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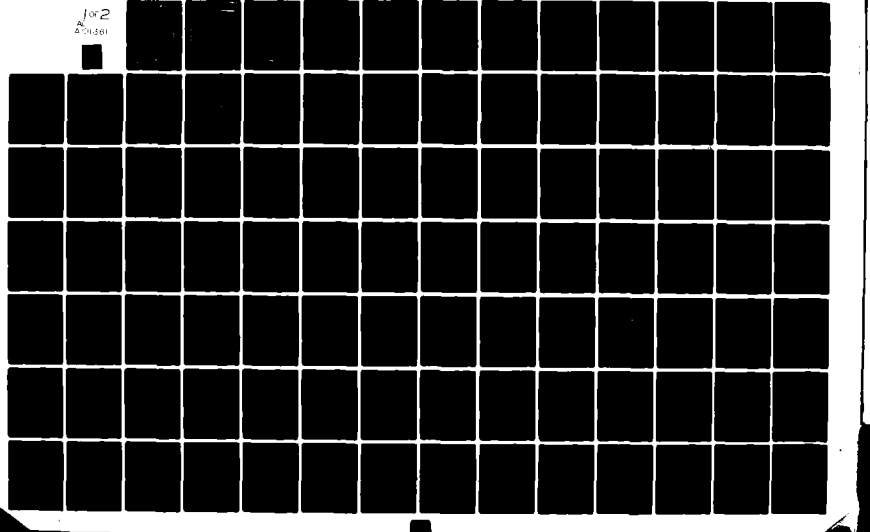

EVALUATION OF DCS III TRANSMISSION ALTERNATIVES PHASE 1A REPORT

APPENDIX B

REGULATORY BARRIERS

26 MAY 1980

Prepared for

Defense Communications Agency
Defense Communications Engineering Center
Reston, Virginia 22090

Contract No. DCA 100–79–C–0044

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This report covers DCS III requirements, transmission media characteristics, regulatory factors, and DCS III transmission system alternatives. Appendix A documents results of transmission-media investigations. Appendix B presents a detailed review of rules, procedures, regulations, standards, and recommendations established by national/international organizations. Appendix C provides a description of topographic and climatic conditions in Germany, Turkey, and Hawaii.

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EVALUATION OF DCS III TRANSMISSION ALTERNATIVES PHASE 1A REPORT

APPENDIX B

REGULATORY BARRIERS

26 MAY 1980

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FOREWORD AND ACKNOWLEDGEMENT

This Appendix B, Regulatory Barriers, is one volume of the four-volume TRW report on Evaluation of DCS III Transmission Alternatives. These four volumes are:

1. Phase IA Report, Evaluation of DCS III Transmission Alternatives
2. Appendix A, Transmission Media
3. Appendix B, Regulatory Matters
4. Appendix C, Regional Consideration and Characterization

The three above appendices present additional information which is intentionally omitted in the main report for clarity and balance.

This Appendix B addresses national, regional, and international regulations, standards, rules, and procedures. These regulatory barriers impact selection of transmission media and alternative system designs of DCS III.

Project work, as documented in the above noted Phase IA Report Evaluation of DCS III Transmission Alternatives and three appendices, has been performed by Defense and Space Systems Group, TRW Inc. and by TRW subcontractor, Page Communications Engineers, Inc., Northrop Corp., for the Defense Communications Engineering Center, Defense Communications Agency, under Contract No. DCA 100-79-C-0044.

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (CONTINUED)

APPENDIX B

REGULATORY BARRIERS

This Appendix B presents a detailed review of rules, procedures, regulations, standards, and recommendations established by some international, regional, and national organizations and agencies. Its purpose substantiate and supplement the summary and outline of regulatory barriers presented in Section 4 of the Phase IA Report on Evaluation of DSC III Transmission Alternatives.

B.1 INTERNATIONAL REGULATORY BARRIERS

The International Telecommunication Union (ITU) is the agency responsible for adequate worldwide radio frequency management and for compatible operation and interface of communications systems developed and operated by various countries. This section reviews ITU rules and procedures which impact selection of transmission media and design alternatives of DCS III transmission systems.

B.1.1 International Telecommunication Union

ITU is a specialized United Nations agency created to maintain international cooperation for improvement and rational use of telecommunications, promote development of technical facilities with a view toward improving efficiency of telecommunications services, increase their usefulness and availability, and harmonize international activity for attainment of these goals. The ITU began as the International Telegraph Union in 1865 in Paris and was renamed the International Telecommunication Union by the 1932 International Telecommunications Convention in Madrid. The present ITU structure was established by the 1974 Plenipotentiary Conference in Atlantic City.

The Plenipotentiary Conference is the supreme organ of the ITU, supported by the Administrative Conference and the Administrative Council, respectively. Permanent organs within the ITU are the General Secretariat, the International Frequency Registration Board (IFRB), the International Radio Consultative Committee (CCIR), and the International Telegraph and Telephone Consultative Committee (CCITT).

International Telecommunications Conventions are equivalent to international treaties in that after they are signed by plenipotentiaries and are properly ratified they become law. Only those regulations approved by the Plenipotentiary Conferences and/or the Administrative Conferences are binding. Recommendations issued by the technical committees are not binding unless they are included in the regulations.

Principal radiocommunication treaties and international agreements signed by the United States and their effective dates are as follows:

1. The International Telecommunication Convention was signed at Malaga-Torremolinos on 25 October 1973 and became effective on 24 March 1976. Radio regulations later annexed to the convention were signed in Geneva on 21 December 1959 and became effective on 23 October 1961.

2. Partial revisions of the Radio Regulations pertaining to space and radio astronomy were signed in Geneva on 8 November 1963 and on 17 July 1972, and became effective on 1 January 1965 and on 1 January 1973 respectively.

3. A partial revision of the Radio Regulations relating to aeronautical mobile (R) communication was signed in Geneva on 29 April 1966 and was entered into force on 23 August 1967, except for the Frequency Allotment Plan, Appendix 27, which entered into force on 10 April 1970. (The United States agreed to implement Appendix 27 in advance of its entry date in successive stages in September of 1968, 1969, and 1970. Details are contained in EFRB Circular Letter No. 176 dated 10 August 1967).

4. Partial revisions of the Radio Regulations pertaining to maritime and mobile communications were signed in Geneva on 3 November 1967 and 8 June 1974 and were entered into force on 1 April 1969 and on 23 March 1976 respectively.

The World Administrative Radio Conference (1979 WARC) that concluded in Geneva in December 1979 rearranged the Radio Regulation and supplied additional Radio Regulations. The Radio Regulation (RR) issued by the 1979 WARC will become effective on 1 January 1982. However, for purposes of the DCS III Study the new Radio Regulation (Ref. B-1) is considered.

Although the new RR will not be available in printed form before September 1980, it is included in this study (taken from a copy of the Final Acts of the 1979 WARC supplied by the State Department). The National Telecommunications and Information Administration (NTIA) will require about one year to review the new RR and more than two years to implement applicable modifications.

B.1.1.1 Radio Frequency Management. The portion of the Radio Regulation pertinent to the DCS III Study concerns frequency allocation and associated aspects of radio-frequency management. A key element is shown in the Table of Frequency Allocation in the Radio Regulations, wherein the usable radio frequency spectrum is divided in bands allocated for specific services in accordance with determinations of cognizant ITU Administrative Radio Conferences. Members and associate members of the Internation Telecommunication Union have agreed that in assigning frequencies to stations capable of causing harmful interference to the services rendered by the station of another country, such assignments are to be made in accordance with established provisions, which are applicable worldwide and are part of the Radio Regulations.

For allocation of frequencies by types of service ITU divides the world into three regions, as shown in Figure B.1-1.

B.1.1.1.1 Types of Services. The types of services considered in the Frequency Allocation Table of the RR are basically the following:

1. Radiocommunication Service: Radiocommunication service involving transmission, emission, or reception of radio waves for telecommunication purposes. Unless otherwise noted, any radiocommunication service cited in RR pertains to terrestrial radiocommunication.

2. Fixed Service: Radiocommunication service between specified fixed points.

3. Fixed-Satellite Service: Radiocommunication service between earth stations at specified fixed points using one or more satellites. This service includes satellite-to-satellite links (inter-satellite service) and also feeder links used for other space radiocommunication services.

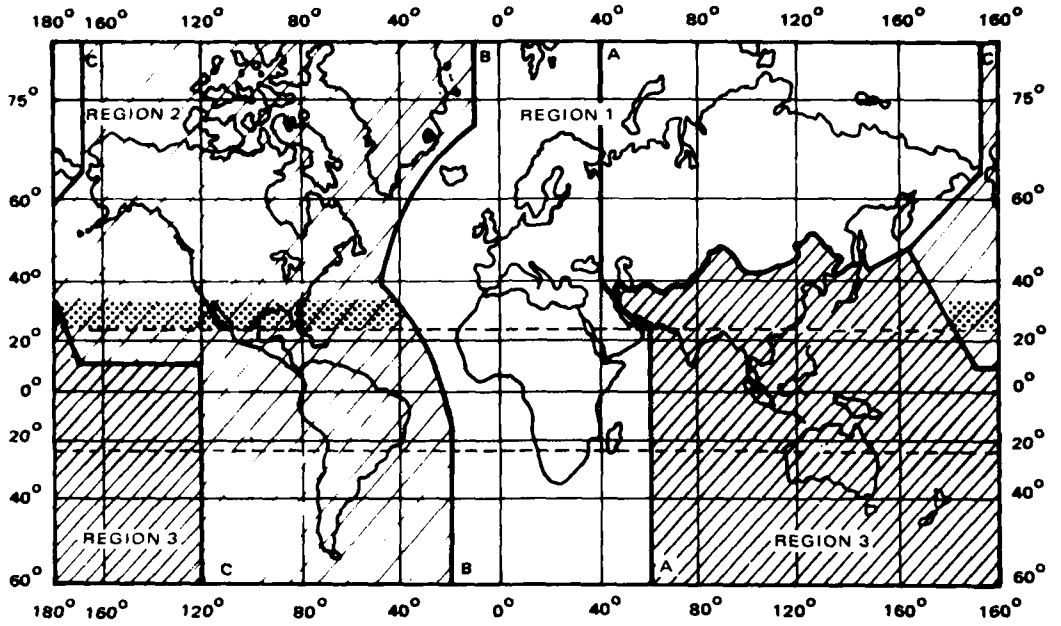


Figure B.1-1. Regions Defined in ITU Table of Frequency Allocations. Shaded Area Represents Tropical Zone

4. Aeronautical Fixed Service: Radiocommunication service between specified fixed points, primarily for the safety of air navigation.

5. Intersatellite Service: Radiocommunication service providing links between artificial earth satellites.

6. Space Operation Service: Radiocommunication service exclusively devoted to operation of spacecraft, particularly space tracking, space telemetry, and space telecommand. These functions normally will be provided within the service area of the space station.

7. Mobile Service: Radiocommunication service between mobile and land stations or between mobile stations.

8. Mobile-Satellite Service: Radiocommunication service between mobile earth stations and one or more space stations, between space stations used by this service, or between mobile earth stations via one or more space stations. This service also includes necessary feeder links.

9. Land-Mobile Service: Mobile service between base stations and land-mobile stations or between land-mobile stations.

10. Land-Mobile Satellite Service: Mobile satellite service utilizing mobile earth stations.

11. Maritime Mobile Service: Mobile service between coast stations and ships, or between ships. Survival-craft stations and emergency position-indicator radiobeacon stations also participate in this service.

12. Maritime Mobile-Satellite Service: Mobile-satellite service in which mobile earth stations are located onboard ships.

13. Port Operations Service: Maritime mobile service in or near a port, between coast stations and ship stations, or between ship stations. Messages are restricted to those relating to operational handling and movement and the safety of ships, and in emergency, personal safety. Messages of a public correspondence nature are excluded from this service.

14. Ship Movement Service: Safety service in the Maritime Mobile Service other than a Port Operations service between coast stations and ship stations or between ship stations, with messages restricted to the movement of ships.

15. Aeronautical Mobile Service: Mobile service between aeronautical stations and aircraft stations or between aircraft stations, in which survival-craft stations may participate. Emergency position-indicating radiobeacon stations also participate in this service on designated frequencies.

16. Aeronautical Mobile-Satellite Service: Mobile-satellite service in which mobile earth stations are located onboard aircraft. Survival-craft stations and emergency position-indicator radiobeacon stations also participate in this service.

17. Broadcasting Service: Radiocommunication service in which transmissions are intended for direct reception by the general public. This service includes sound transmissions and television transmissions.

18. Broadcasting-Satellite Service: Radiocommunication service in which signals transmitted or retransmitted by space stations are intended for direct reception by the general reception and community reception.

19. Radiodetermination Service: Radiocommunication service for radiodetermination.

20. Radiodetermination-Satellite Service: Radiocommunication service for radiodetermination using one or more space stations.

21. Radionavigation Service: Radiodetermination service for radionavigation.

22. Radionavigation-Satellite Service: Radiodetermination-satellite service for radionavigation. This service also includes feeder links.

23. Maritime Radionavigation Service: Radionavigation service for safe operation of ships.

24. Aeronautical Radionavigation-Satellite Service: Radionavigation-satellite service with earth stations located onboard.

25. Maritime Radionavigation-Satellite Service: Radionavigation-satellite service with earth stations located onboard ships.

26. Aeronautical Radionavigation Service: Radionavigation service for safe operation of aircraft.

27. Aeronautical Radionavigation-Satellite Service: Radionavigation-satellite service with earth stations located onboard aircraft.

28. Radiolocation Service: Radiodetermination service for radiolocation.

29. Meteorological Aids Service: Radiocommunication service for meteorological and hydrological observation and exploration.

30. Earth-Exploration-Satellite Service: Radiocommunication service between earth stations and one or more space stations, including links between space stations and possibly feeder links required for service operation, whereby:

- Information relating to the characteristics of the earth and its natural phenomena is obtained from active or passive sensors on earth satellites.
- Information is collected from airborne or earth-based platforms.
- Such information may be distributed to earth stations within the system concerned.
- Platform interrogation may be included.

31. Meteorological-Satellite Service: Earth-exploration-via-satellite service.

32. Standard-Frequency and Time-Signal Satellite Service: Radiocommunication service using space stations on earth satellites for the same purposes as those of the Standard-Frequency and Time-Signal service. This service also includes necessary feeder links.

33. Space Research Service: Radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes.

34. Amateur Service: Radiocommunication service for purposes of self-training, intercommunication, or technical investigations carried out by amateurs (duly authorized persons interested in radio techniques solely with a personal aim and without pecuniary interest).

35. Amateur-Satellite Service: Radiocommunication service using space stations on earth satellites for the same purposes and as those of the Amateur Service.

36. Radio Astronomy Service: Radiocommunication service involving use of radio astronomy.

37. Safety Service: Any radiocommunication service used permanently or temporarily for safeguarding human life and property.

38. Space Service: Radiocommunication service not otherwise defined in this section used exclusively for specific needs of general utility and not open to public correspondence.

B.1.1.1.2 Priority of Allocations. Some bands are allocated to only one service and others to two or more services. In the latter case all services may be allocated with the same rights, or some services may have priority over others.

Allocated services may be classified as primary, permitted, and secondary services. Primary and permitted services have equal rights for operating in the band, except that in the preparation of frequency plans the primary service shall have prior choice of frequencies.

Operation of secondary service stations must not cause harmful interference to stations of primary or permitted service and they cannot claim protection from harmful interference from those stations. Secondary service stations can claim protection only from other secondary services to which frequencies may be assigned at a later date.

Some countries or groups of countries may reserve the right to use specific bands for different services than those intended. Such exceptions are included in the RR.

B.1.1.1.3 Frequency Registration. Essential duties of the International Frequency Registration Board (IFRB) are:

- To record frequency assignments made by the different countries in order to establish in accordance with the ITU Radio Regulations and with any decisions taken by ITU conferences the date, purpose, and technical characteristics of each assignment, with view toward ensuring formal international recognition.

- To advise members and associate members in the operation of the maximum practicable number of radio channels and to identify those portions of the spectrum in which harmful interference may occur.

- To perform any additional duties concerned with the assignment and utilization of frequencies prescribed by an ITU conference or by the Administrative Council.

- To maintain essential records.

The members of IFRB are elected by a Plenipotentiary Conference and act as an independent body. They are thoroughly qualified by technical training in the field of radio and have practical experience in assignment and utilization of frequencies. The board is assisted by a specialized secretariat.

Any frequency assignment to a fixed, land, broadcast, radionavigation, radiolocation, standard frequency, time-signal, or ground-based meteorological station or to an earth or space station shall be registered by the IFRB in accordance with the following:

- If use of the frequency is capable of causing harmful interference to any other service.

- If the frequency is to be used for international radiocommunication.

- If it is necessary to obtain international recognition of the frequency use.

- If and wherever coordination outside of national borders is required.

Similar frequency registering notices must be accomplished for any new frequency assigned for reception of transmissions from earth or space stations if one or more of the conditions specified above are applicable, and also for any frequency or frequency band that is to be used for reception by a particular radio astronomy station if it is desired that such data be included in the Master Register.

Appendix 1 of the RR explains how to submit frequency notices and the information to be supplied. Chapter IV establishes specific rules to be followed by the IFRB in effecting the registration, coordinating between space and terrestrial services sharing the same band, checking for mutual interferences, and negotiating with the countries concerned in case of harmful interferences.

An important rule governing the relative priority of the registration is that a new user of a frequency registered by the IFRB may not use that frequency until a check is made on the possibility of interference with previously registered users.

B.1.1.2 Frequency Spectrum Utilization Restrictions. Regarding evaluation of DCS III Transmission Alternatives, pertinent limitations imposed by the RR relating to frequency-spectrum utilization are as follows:

B.1.1.2.1 Bandwidth Limitation. The bandwidth limitations are:

a. Class F3E (radiotelephone FM) and G3E (radiotelephone PM) emissions are prohibited in fixed services below 30 MHz.

b. Administrations are urged to discontinue use of double-sideband radiotelephone (A3E).

B.1.1.2.2 Bands Shared Between Terrestrial and Space Communications. In frequency bands shared equally between terrestrial and space services, restrictions apply to site frequency selection, antenna azimuth, and power. Article 25 of the RR establishes restrictions applicable to terrestrial service stations, and Articles 26 and 27 cover those governing space services. Specific bands affected are identified below:

a. Terrestrial Service

- Sites and frequencies for terrestrial stations operating in frequency bands shared equally between terrestrial radiocommunication and space radiocommunication services shall be selected in accordance with CCIR recommendations addressing geographical separation from earth stations.

- To the practicable degree, sites for transmitting stations in fixed or mobile modes and employing maximum values of equivalent isotrophically-radiated power (EIRP) exceeding +35 dBw in the frequency bands between 1 and 10 GHz should be so selected that the direction of maximum radiation from any antenna will be at least 2^{0} from the geostationary satellite orbit, taking into account the effect of atmospheric refraction. In the 10-GHz to 15-GHz frequency band, sites for transmitting stations in fixed or mobile modes employing maximum values of EIRP exceeding +45 dBw should be so selected that the direction of maximum radiation from any antenna will be at least 1.5^{0} away from the geostationary satellite orbit, taking into account the effect of atmospheric refraction.

- Currently, no restriction exists on the direction of maximum radiation for stations in fixed or mobile modes in frequency bands above 15 GHz.

- The maximum EIRP of stations in fixed or mobile modes shall not exceed +55 dBw. Where such compliance is impracticable, the maximum EIRP of a station in a fixed or mobile mode shall not exceed the following limits:

  - +47 dBw in any direction within 0.5^{0} of the geostationary satellite orbit.

  - +47 dBw to +55 dBw, on a linear decibel scale (8 dB/degree) in any direction between 0.5^{0} and 1.5^{0} of the geostationary satellite orbit, taking into account the effect of atmospheric refraction.

- The power delivered by a transmitter to the antenna of a station in fixed or mobile service in frequency bands between 1 and 10 GHz shall not exceed +13 dBw.

- The power delivered by a transmitter to the antenna of a station in fixed or mobile service in frequency bands above 10 GHz shall not exceed +10 dBw.

b. Space Services

- Sites and frequencies for earth stations operating in frequency bands shared equally between terrestrial radiocommunication and space radiocommunication services shall be selected with regard to relevant CCIR recommendations concerning geographical separation from terrestrial stations.

- The EIRP transmitted in any direction toward the horizon by an earth station operating in frequency bands between 1 and 15 GHz shall not exceed the following limits except as provided in RR Items 6044/470H and 6042/470GC.

  - +40 dBw in any 4 kHz band for $\theta < 0^{o}$

  - +40 +3θ dBw in any 4 kHz band for $0^{o} < \theta < 5^{o}$

  where 0 = angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in positive degrees above the horizontal plane and negative degrees below it.

- The EIRP transmitted in any direction toward the horizon by an earth station operating in frequency bands above 15 GHz shall not exceed the following limits:

  - +64 dBw in any 1-MHz band for $\theta < 0^{o}$

  - +64 +3θ dBw in any 1-MHz band for $0^{o} < \theta < 5^{o}$

  The two exceptions are (1) that the upper limits may not be exceeded by more than 10 dB unless the resulting coordination area extends into another country, when such increase shall be subject to agreement by that country's administration and (2) that the EIRP toward the horizon for an earth station in space research service (deep-space) shall not exceed +79 dBw in any 1-MHz band.

- Earth-station antennas shall not be employed for transmission at elevation angles of less than 3^0 measured from the horizontal plane to the direction of maximum radiation except when agreed to by the Administrations concerned and by those whose services may be affected. In the case of reception by an earth station, the above value shall be used for coordination purposes if the operating angle of elevation is less than that value.

- Earth-station antennas in Space Research service (near-earth) shall not be employed for transmission at elevation angles of less than 5^o, and earth station antennas in Space Research service (deep-space) shall not be employed for transmission at elevation angles of less than 10^o, both angles being those measured from the horizontal plane to the direction of maximum radiation. In the case of reception by an earth station, the above values shall be used for coordination purposes if the operating angle of elevation is less than those values.

- The power flux density at the earth surface produced by emissions from a space station (Broadcasting or Fixed service, as applicable), including emissions from a reflecting satellite, and for all conditions and methods of modulation, shall not exceed the values given in Table B.1-1.

- Procedures for coordinating of terrestrial and/or space services assignments are given in the following appendices to the RR: Appendices 28 (Coordination Area Around An Earth Station), Appendix 29 (Geostationary Satellite Networks Sharing the Same Frequency Band); Appendix 29A (All Services and Associated Plan for Broadcasting Satellite Service, 11.7- to 12.5-GHz bands).

B.1.1.2.3 Frequency Management Above 40 MHz. In principle, the RR applies only to cases where harmful interferences results outside a national border. For terrestrial systems above 40 MHz, where interference ranges are limited and may be adequately predicted, any country therefore could, in principle, allocate desired frequencies providing the interference range would be inside the national borders. (This may offer some flexibility in preparing national frequency allocation plans, although most countries closely follow the structure established by the RR).

Table B.1-1. Power Flux Denisty Limits at Earth Surface From Space Stations Sharing with Fixed and Mobile Services and with Meteorological Aids Service

Frequency Band (MHz)	Region	Angle of Arrival (δ) Above Horizontal Plane in Degrees		
		0 - 5°	5 - 25°	25 - 90°
(Fixed and Mobile Services)				
1525 - 1530	1 and 3	-154 dBw/m^2/ 4 kHz	-154 + (δ - 5)/ 2 dBw/m^2/4 kHz	-144 dBw/m^2/ 4 kHz
1530 - 1535	1 and 3 (up to Jan 1990)			
1670 - 1690	All		Note 5	
1690 - 1700	Note 1			
1700 - 1710	All			
2290 - 2300				
2500 - 2690	All	-152 dBw/m^2/ 4 kHz	-152 + 0.75 (δ - 5) dBw/ m^2/4 kHz	-137 dBw/m^2/ 4 kHz Note 5
3400 - 4200	All	-152 dBw/m^2/ 4 kHz	-152 + (δ -5)/ 2 dBw/m^2/4 kHz	-142 dBw/m^2/ 4 kHz
4500 - 4800	All			
5670 - 5725	Note 2			
7250 - 7750	All			
8025 - 8500	All	-150 dBw/m^2/ 4 kHz	-150 + (δ - 5)/ 2 dBw/m^2/4 kHz	-140 dBw/m^2/ 4 kHz

Table B.1-1. Power Flux Density Limits at the Earth Surface from Space Stations Sharing with Fixed and Mobile Services and with Meteorological Aids Service (Concluded)

Frequency Band (GHz)	Region	Angle of Arrival (δ) Above Horizontal Plane in Degrees		
		0 - 5°	5 - 25°	25 - 90°
10.7 - 11.7				
12.2 - 12.5	3	-148 dBw/m^2/ 4 kHz	-148 + (δ - 5)/ 2 dBw/m^2/4 kHz	-138 dBw/m^2/ 4 kHz
12.50 - 12.75	Note 3			
17.7 - 19.7	All	-115 dBw/m^2/ 1 MHz	-115 + (δ - 5)/ 2 dBw/m^2/1 MHz	-105 dBw/m^2/ 1 MHz
31.0 - 31.3	All			
34.2 - 35.2	Note 4			
37.5 - 40.5	All			
(Meteorological Aids Service)				
1690 - 1700			-133 dBw/m^2/1.5 MHz for all angles of arrival	

Note 1: On territory of countries cited in RR Items 3698 and 3698B.

Note 2: On territory of countries cited in RR Items 3757 and 3758A.

Note 3: In Regions 1 and 3 on the territory of countries cited in RR Items 3788 and 3788A.

Note 4: For space-to-earth transmission under RR Items 3808 and 3808A on the territories of the countries cited in RR Items 3794.

Note 5: The power-flux density values shown are derived on the basis of protecting the fixed service using line-of-sight techniques. Where a fixed service using tropospheric scatter operates in the shared band and where there is insufficient frequency separation, sufficient angular separation must exist between the direction to the space station and the direction of maximum radiation of the antenna of the receiving station of the fixed service using tropospheric scatter to ensure that the interference power at the receiver input of the station of the fixed service does not exceed -168 dBw in any 4-kHz band.

B.1.1.3 1979 WARC - Trend and Changes. It is not possible to identify all significant trends in the 1979 WARC. The United States and other developed countries have attended this conference with certain objectives, but these could not be fully met due to conflicts of interest with developing countries. Among those objectives, the following are of interest:

a. Reduction of Fixed Service in HF Bands. The United States sought reduction of the HF frequency bands allocated to Fixed service so that the allocation to HF Mobile Maritime and HF Broadcasting services could be increased. However, it was not possible to obtain substantial reduction below 11 MHz due to heavy use of HF by developing countries for short-distance communication. Above 11 MHz, frequency bands allocated to Fixed services have been reduced by about 14 percent.

b. Increase of Bands Allocated to Maritime Mobile Satellite. Another objective was increase of the Maritime Mobile Satellite band allocation operating in the 1.5-GHz range. This was in large part achieved by the following modifications:

- Previous band allocations of 1535-1558.5 MHz (down link) and 1636.5-1600 MHz (uplink) to the Maritime Mobile Satellite and Aeronautical Mobile Services have been extended to 1530-1559 MHz and 1626.5-1660.5 MHz respectively.

- The previous allocation included two sub-bands shared by Maritime and Aeronautical services with equal rights. Those bands were split between the two services, with the Maritime Mobile service assigned the larger share.

- From the overall arrangement, the frequency spectrum in the bands allocated exclusively to Maritime Mobile Satellite service was increased from 7.5 to 14 MHz (down link) and from 7.5 to 19 MHz (uplink).

- Two 1-MHz bands were allocated to Mobile Satellite services for distress and safety operations only.

c. Allocation of 1215-1530 MHz to Space Operation and Radio Astronomy. The Conference attempted to eliminate the Fixed service from the 1215-1530 MHz band and to use that frequency band for Space Operation and Radio Astronomy services only. However, in Region 1 this would impact NATO systems, and accordingly in Region 1 some frequency blocks within that frequency range are still shared between Space Operation and Fixed services with equal rights.

d. Allocation of 1710-2290 MHz in Exclusive to Fixed Service. The frequency band 1710-2290 MHz is exclusive to Fixed service as a primary allocation. However, Space Operation service is still possible in some frequency blocks subject to agreement.

e. Increase of Bands Below 10 GHz Allocated to Fixed Satellite. The bands below 10 GHz, shared with equal rights between fixed satellite and terrestrial systems, have been increased from 2550 to 2655 MHz and from 6425 to 7075 MHz.

f. Requirements for Intersatellite Service. The Conference recognized the importance of having adequate bands for intersatellite communication at frequencies above and below 40 GHz. A new frequency band of 22.5-23 GHz was allocated to Intersatellite Communication, shared with equal rights between Fixed, Mobile, and Broadcasting Satellite (Region 2 only) services. Above 40 GHz, the bands of 54.25 GHz - 68.2 GHz, 59 GHz - 64 GHz, 116 GHz - 134 GHz, 170 GHz - 182 GHz and 185 GHz - 190 GHz, allocated by the 1971 WARC exclusively to the intersatellite services, are now shared with terrestrial services. The rationale for the sharing is that those bands are located in parts of the radio frequency spectrum close to peaks of atmospheric absorption. However, by Recommendation 0, the CCIR was requested to study the sharing criteria.

g. Broadcasting Satellite Above 10 GHz. The bands allocated to Broadcasting Satellite in the 11.7- GHz to 12.2-GHz (in Regions 2 and 3) were not changed by the 1971 WARC. However, special provisions (Appendix 29 of the new RR) have been established. In Region 2, a new band of 22.5 GHz - 23 GHz was opened for use by Broadcasting Satellite in Region 2. New bands above 40 GHz were allocated.

h. Bands Allocated to Terrestrial Services Above 28.5 MHz. In spite of large development of the Fixed Satellite services, there was no noticeable trend in the Conference of reducing microwave bands allocated to Terrestrial Fixed and Mobile services above 28.5 MHz.

i. General Trend Above 10 GHz. The general trend for frequencies from 10 GHz to 275 GHz was to establish a rational allocation to account not only for requirements already existing between 10 and 40 GHz but also to anticipate technological advances allowing operation above 40 GHz.

j. Radio Astronomy. The Conference has tried to accommodate the needs of Radio Astronomy, a relative young science. Below 28.5 MHz, Radio Astronomy has acquired some rights, moving in some of the bands from an allocation in secondary basis to equal rights. Also, special protection was allowed in particular bands where Radio Astronomy measurements are being carried. Above 10 GHz, some new bands were open to the Radio Astronomy.

B.1.1.4 New Conferences to be Convened in the Near Future. The 1979 WARC has resolved to convene the following assemblages:

a. Planning Conference to draw up an agreement and associated plan for sound broadcasting in the 87.5-108 MHz for Region 1 and for those parts of Afghanistan and Iran which are contigious to Region 1. The conference is to be convened not later than 31 December 1983 (Resolution BM).

b. Regional Administrative Radio Conference for detailed planning of the Broadcasting Satellite service in the 12-GHz band and of associated feeder links in Region 2. The Conference is to be convened not later than 1983 (Resolution CH 1).

c. Regional Broadcasting Conference to review and revise provisions of the Final Acts of the African VHF/UHF Broadcasting Conference (Geneva 1963). No date set (Resolution CQ).

d. World Administrative Radio Conference for Mobile Service to revise provisions of the Radio Regulation which relate specifically to those services. No date set (Resolution DH).

e. World Administrative Radio Conference for planning the HF bands allocated to Broadcasting services. To be convened as soon as possible after the next CCIR Plenary Assembly (Resolution DI).

f. Regional Administrative Radio Conference to establish criteria for shared use of the VHF and UFH bands allocated to Fixed, Broadcasting, and Mobile services in Region 3. No date has been set (Resolution DK).

B.1.1.5 Importance of the RR in the DCS III Study. The ITU Radio Regulation offers a means to appraise viability of the alternatives to be considered in the DCS III Study because most countries comply with the RR in their frequency assignments. However, the RR does not thoroughly cover alternatives for stations to be installed in particular countries. Instead, detailed knowledge of the national regulations of those countries is necessary in that national regulations may limit use of some bands and impose additional restrictions on the operating characteristics of particular stations.

One rule contained in the RR that may have a direct impact in the DCS III Study is the requirement to notify and register the operating frequency with the IFRB. That requirement, particularly when the station is not operated by a national agency of a country, could result in some administrative and legal problems.

The minimum equipment standards established by the RR probably will not be of importance to the DCS III Study because those standards are well within the state-of-the-art. Also, operational rules established by the RR for some services are not pertinent to the DCS III Study.

B.1.1.6 Technical Committees of ITU. The two ITU technical committees are the International Telegraph and Telephone Consultative Committee (CCITT) and the International Radio Consultative Committee (CCIR). These committees perform elaborate studies on pertinent aspects of telecommunications techniques and prepare standards for compatibility at the interface between different countries. Both final results of these studies and subsequent standards are presented in the form or recommendations. The CCIR concerns itself with systems using radio transmission media and the CCITT deals with systems using physical media and end-line equipment.

Any forthcoming recommendations are not binding. Those recommendations for procedures on system performance are optional for use in the DCS III Study, depending on availability of other more reliable sources of data. Recommendations concerning technical standards for systems interface points have been adopted by all countries and will have a direct effect on the DCS III Study concerning transmission alternatives, including interfaces with national networks and systems.

CCIR and CCITT are treated separately herein, with details further elaborated in Sections B.1.2 and B.1.3 respectively.

B.1.2 International Radio Consultative Committee

The International Radio Consultative Committee (CCIR), as one of two technical committees created by the International Telecommunication Union, studies technical and operating factors of radiocommunication and issues resulting recommendations. In the performance of its duties CCIR formulates recommendations directly affecting establishment, development, and improvement of telecommunication in new or developing countries. The CCIR focuses on issues raised by the Plenipotentiary Conference, Administrative Conferences, the Administrative Council, the IFRB, and members of the Plenary Assembly of the CCIR itself. The CCIR Plenary Assembly meets every four years. In the interim, studies are carried on by twelve work groups.

B.1.2.1 CCIR Work Groups. The twelve CCIR working groups are listed Table B.1-2 for reference.

B.1.2.2 Influence of CCIR in DCS III Study. CCIR is a technical committee which has no regulatory power. Output from CCIR is presented in the form of recommendations, reports, questions, study programs, resolutions, and opinions. Only the recommendations are presented for adoption by CCIR members. CCIR recommendations usually pertain to the following topics:

- System Design Objectives
- Equipment Minimum Performance Objectives
- Interface Characteristics

Table B.1-2. CCIR Study Groups*

Study Group	Discipline Addressed
1	Spectrum utilization and monitoring
2	Space research and radio astronomy services
3	Fixed service at frequencies below 30 MHz
4	Fixed service using communications satellites
5	Propagation in non-ionized media
6	Propagation in ionized media
7	Standard-frequency and time-signal service
8	Mobile service
9	Fixed service using radio relay systems
10	Broadcasting service (sound)
11	Broadcasting service (television)
12	Transmission of sound broadcasting and television signals over long distance (joint CCIR/CCITT study group)

*Details regarding these study groups are given in the CCIR (Ref. B-2)

- Operation and Maintenance
- Transmission Media Modeling

It is important to realize that with exception of the United States CCIR recommendations are usually adopted by all international operating agencies. Accordingly, for portions of the DCS III Study pertaining to networks outside the United States or to systems having worldwide projection, CCIR recommendations and reports can be important. The most pertinent matters include limitations imposed on equipment characteristics that may interfere with other systems and, in cases where the DCS system integrates with national systems, interface characteristics and design objectives of the national systems.

B.1.2.3 CCIR Recommendations and Reports. Documentation originated by the CCCIR XIVth Plenary Assembly at Kyoto, Japan in 1978 (Ref. 1) consists of 13 volumes containing well over 4,000 pages. Because even a very brief summary of related recommendations and reports contained within that material would require more space than is devoted to this present Appendix A, Subsection B.1.2.3 therefore has been limited to identification and categorization of those recommendations and reports having direct impact on DCS III alternative-system design. Table B.1-3 identifies recommendations specifying characteristics of radio-relay systems for various and individual relay-system capacities, Table B.1-4 lists related reports, and Tables B.1-5 and B.1-6 respectively cite the recommendations and reports which specify characteristics of communications satellites.

B.1.3 International Telegraph and Telephone Consultative Committee.

The International Telegraph and Telephone Consultative Committee (CCITT) is the second technical committee created by the International Telecommunications Union. This committee studies technical, operating, and tariff questions related to communication and issues related to recommendations. The CCITT develops new recommendations and updates existing ones through activities of study groups, whose reports are acted on at Plenary Assemblies that meet at intervals of four years. Details regarding information addressed in this section are given in the Orange Book of 1976 (Ref. B-3).

Table B.1-3. CCIR Recommendations Specifying Radio-Relay Systems

Relay-System Characteristics	Applicable Frequency Bands	Maximum Relay-System Telephone-Channel Capacity													
		1	6	12	24	60	120	300	600(1)	900/ 960(1)	1200/ 1260(1)	1800	2700	Television	Trans-horizon
Occupied bandwidth	Bands 8 and 9														388
Number of radio-frequency channels	2 GHz					←	283-2	→	←	382-2	→	→		382-2	
Centre frequencies and radio-frequency channel arrangements	4 GHz								←	382-2	→	→		382-2	
Polarization arrangements	6 GHz								381-1		384-2	383-1	384-2	383-1, 384-2	
	7 GHz					←	385	→							
	8 GHz							386-1		386-1				386-1	
	11 GHz								←	387-2	→	→		387-2	
	13 GHz									497				497	
Interconnection at:															
audio frequencies				←				268-1	→				→		
baseband frequencies					←			380-3	→				→		
intermediate frequencies					←					403-2	→			→	
video frequencies														270-1	
Hypothetical reference circuit				←	391	→	←			392	→	→	→		396-1
Allowable noise power in the hypothetical reference circuit				←					393-2	→	→	→	→	289-1, 462	397-2
Noise in the radio portions of real circuits				←					395-1	→	→	→	→		
Frequency deviation				←				404-2	→	→	→	→	→	276-2	404-2
Pre-emphasis and de-emphasis characteristics					←				275-2	→	→	→	→	405-1	275-2
Line regulating and other pilots					←					→	401-2	→	→	→	→
Signalling and service channels						←				→	400-2	→	→	→	→
Stand-by arrangements						←				305	→	→	→	→	
Auxiliary radio-relay systems						←			389-2	→	→	→	→	→	
Residues of signals outside the baseband						←			381-2	→	→	→	→	463	381-2
Maintenance measurement in actual traffic					←				398-3	→	→	→	→		
Measurements of performance with the help of a signal consisting of a uniform spectrum						←			399-2	→	→	→	→		

Table B.1-4. Radio-Relay Systems Characteristics Specified in CCIR Reports

Characteristic	Report
Hypothetical reference circuit	378-2
Selection of coding and modulation techniques	378-2
Interconnection at baseband frequencies	378-2
Radio-frequency channel arrangements:	
General principles	608
For Band 11.7-15.35 GHz	607
For Band 17.7-19.7 GHz	609
Propagation effects	611
Radio-frequency interference	605, 606
Diversity techniques	376-2
Bit error performance measurements	613
Interference noise calculation	388-2
Technical characteristics requiring specification to enable interconnection of any two systems	283

Table B.1-5. Communication Satellite Characteristics Specified in CCIR Recommendations

Characteristic	Recommendation	
	Telephone	Television
Hypothetical reference circuit	352-2	352-2
Allowable noise power in phyothetical reference circuit	353-2	354-2
Pre-emphasis characteristics	464	
Maximum permissible levels of interference	466-1	483
Measurement of performance by means of signal	482	
Measurement of noise in actual traffic	481	

Table B.1-6. Communication Satellite Characteristics Specified in CCIR Reports

Characteristics	Report
General summary of technical factors influencing satellite efficiency	453-1
Hypothetical reference circuit and noise standard	208-3
Methods of modulation and multiple access	211-3
Methods of modulation, multiplexing, orbital parameters and earth-station sensitivity	213-3
Effect of modulation characteristics on efficiency	559
Pre-emphasis in frequency-modulation systems	212-3
Interference noise calculation	388-2
Earth-station antennas	390
Use of frequency bands above 10 GHz	552

B.1.3.1 CCITT Work Groups. The CCITT Plenary Assembly also meets every four years. In the interim, studies are carried on by 21 study groups, three of which are CCIR/CCITT Joint Study Groups. In addition, the CCITT includes five plan committees administered by the CCITT, special autonomous working parties, and four regional tariff groups. These groups, committees, and parties, and their areas of investigation and study are listed in Table B.1-7.

B.1.3.2 Influence of CCITT in the DCS III Study. Output from the CCITT is presented in the form of recommendations, reports, questions, study programs, resolutions, and opinions. Only the recommendations are presented for adoption by the CCITT Members. CCITT recommendations cover all technical aspects pertaining to interface of circuits installed and operated by different countries and to compatibility of the end equipments and maintenance specifications, thus ensuring that international lines operate satisfactorily. An important conclusion of the DCS III Study that due to the advantage existing in future use of international networks as alternative routing for the DCS, the study should include a recommendation to establish a coordinating study group within the DoD for the purpose of checking compatibility of the MIL-STD and DCS procedures against CCITT recommendations.

B.1.3.3 CCITT Recommendations. New recommendations and updates of existing recommendations developed by the CCITT study groups are acted on at CCITT plenary assemblies. Recommendations of the VIth Plenary Assemblies at Geneva, Switzerland in 1976(Ref. B-3)were published by the ITU in volumes collectively designated as the Orange Books. CCITT Recommendations were numbered, the identification number of each recommendation including letter prefix referring to the series as well as a reference number.

Following Tables B.1-8 through B.1-10 characterize major recommendations of the G-, Q- and V-series. The G-series, dealing with characteristics of media, is of greatest impact on transmission system design, and the Q- and V-series deal with switching and signaling, and with data transmission respectively. These tables specifically identify the scope of the recommendation series addressed as well as the particular CCITT volume in which a particular recommendation appears.

Table B.1-7. CCITT Work Groups Summary

Work Group	Area of Investigation
CCITT STUDY GROUPS (21)	
Study Group I	Telegraph operation and quality of service
Study Group II	Telephone operation and quality of service
Study Group III	General tariff priniciples
Study Group IV	Transmission maintenance of international lines; circuits and chains of circuits; maintenance of automatic and semi-automatic networks
Study Group V	Protection against dangers and disturbances of electromagnetic origin
Study Group VI	Protection and specifications of cable sheaths and poles
Study Group VII	New networks for data transmission
Study Group VIII	Telegraph and terminal equipment, local connecting lines
Study Group IX	Telegraph transmission quality; specification of equipment and of rules for maintenance of telegraph channels
Study Group X	Telegraph switching
Study Group XI	Telephone switching and signalling
Study Group XII	Telephone transmission performance; local telephone networks

Table B.1-7. CCITT Work Groups Summary (Continued)

Work Group	Area of Investigation
Study Group XIII	
Study Group XIV	Facsimile telegraph transmission and equipment
Study Group XV	Transmission systems
Study Group XVI	Telephone circuits
Study Group XVII	Data transmission (former Special D)
CCITT/CCIR Joint Study Group (CMBD) (formerly Special C)	Circuit noise and availability
CCIR/CCITT Joint Study Group (CMTT)	Television and sound transmission
CCIR/CCITT Joint Study Group (CMU)	Definitions and symbols for vocabulary
PLAN COMMITTEES (4)	
(CCITT/CCIR JOINT COMMITTEES ADMINISTERED BY CCITT)	
World Plan Committee	Worldwide Telecommunication Plan
Plan Committee for Africa	Telecommunication Plan for Africa
Plan Committee for Latin America	Telecommunication Plan for Latin America
Plan Committee for Asia	Telecommunication Plan for Asia and Oceania
Plan Committee for Europe and the Mediterranean Basin	Telecommunication Plan for Europe and the Mediterranean Basin

Table B.1-7. CCITT Work Groups Summary (Concluded)

Work Group	Area of Investigation
SPECIAL AUTONOMOUS WORKING PARTIES (3)	
GAS 3	Economic and technical aspects of the choice of transmission systems
GAS 5	Economic conditions and telecommunication development
GAS 6	Economic and technical aspects of the choice of switching systems
REGIONAL TARIFF GROUPS (4)	
GR TAF	Tariffs (Africa)
GR TAL	Tariffs (Latin America)
GR TAS	Tariffs (Asia and Oceania)
GR TEUREM	Tariffs (Europe and the Mediterranean Basin)

Table B.1-8. CCITT G-Series Recommendations

Scope and Subject Description	Recommendation
(International Telephone Connections and Circuits)	
General; transmission plan, standard components in transmission equipment, hypothetical reference connections	G.101-G.104
Transmission quality for international connections; reference equivalents, transmission impairments and noise, propagation time	G.111-G.116
National systems forming part of international connections; reference equivalents, transmission characteristics, stability and echo in international connections, circuit noise in networks, echo in connections	G.120-G.125
4-wire chain formed by international circuits and national extension circuits; stability and echo, attenuation distortion, group delay distortion crosstalk, transmission losses, circuit noise and use of compandors	G.131-G.135 G.141-G.143
International telephone circuits and national extension circuits; same as above	G.151-G.153
Apparatus associated with long distance telephone circuits; echo suppressors, compandors for telephone, call concentrating systems	G.161-G.163
(Analog Carrier-Transmission Systems)	
Definitions and general considerations; hypothetical reference circuits, interconnections of systems in a main repeater, line stability of cable systems	G.211-G.214
General recommendations; carrier-transmission systems, noise on a real link, power level, accuracy of carrier frequencies, telephone signal, noise calculation in circuits, interference at harmonics	G.221-G.230
Translating equipment; arrangement of carrier equipment, 8-, 12-, and 16-channel terminal equipments	G.231-G.235
Utilization of groups, supergroups, etc., pilots, through connection, protection of pilots	G.241-G.243

Table B.1-8. CCITT G-Series Recommendations (Continued)

Scope and Subject Description	Recommendation
(International Carrier Telephone Systems on Metallic Lines)	
Systems on an open-wire pair; intermediate repeaters, characteristics for 8- and 12- carrier telephone circuits	G.311-G.314
Systems on unloaded symmetric cable pairs; transistor-type systems, valve-type systems	G.321-G.327
Systems on 2.6/9.5-mm coaxial cable pairs; general characteristics, 12- and 60- MHz transistorized systems, 4- and 12- MHz valve-type systems	G.331-G.333 G.337-G.339
Systems on 1.2/4.4-mm coaxial cable pairs; 1.3-, 4-, 6-, and 12- MHz systems	G.341-G.346
Other systems; interconnection of coaxial systems of different types, three carrier telephone circuits on a pair of open-wire lines systems for submarine cable	G.352-G.356 G.361-G.371
(International Carrier Telephone Systems on Radio-Relay or Satellite Links and Interconnection with Metallic Lines)	
General recommendations; use of radio-relay systems, terminal equipment	G.411-G.412
Interconnection of radio-relay systems with carrier systems on metallic lines; method of interconnection, interconnection at audio or baseband frequencies	G.421-G.423
Hypothetical reference circuits; for FDM, tropospheric-scatter, and communication-satellite systems	G.431-G.433 G.434
Circuit noise; permissible noise for tropospheric scatter or communication-satellite system design	G.441-G.442 G.444, G.445
Radiotelephone circuits; intercontinental radio-telephone systems and use of radio links, inter-connection of two radiotelephone circuits	G.451-G.452
Devices associated with radio circuits, devices for measurement and regulation of speech volume, fading correctors, feedback suppressors and echo suppressors, device for achieving privacy of conversations	G.461-G.464

Table B.1-8. CCITT G-Series Recommendations (Concluded)

Scope and Subject Description	Recommendation
(Audio Frequency Circuits)	
Recommendations applying to characteristics of audio-frequency circuits, interconnection of international circuits	G.511-G.512
Audio-frequency lines; open-wire lines and composite lines, audio-frequency cables	G.521-G.522
Repeaters; characteristics for 2- or 4- wire circuits and for the junction of two cables	G.531-G.533
Specifications recommended by CCITT for factory lengths of cable, loading coils, repeater section, terminal equipment, and intermediate repeater section	G.541-G.543
(Characteristics of Transmission Media)	
Symmetric cable pairs for the transmission of systems with bit rates of the order of 6 to 34 Mbps	G.612
Land coaxial-pair cables; 0.7/2.9-mm, 1.2/4.4-mm, and 2.6/9.5-mm coaxial cable pairs	G.621-G.623
Submarine cables; types for systems with line frequencies of less than about 45 MHz	G.631
Waveguide diameters	G.641
(Digital Transmission Systems, Terminal Equipments, Network and Line Section)	
General framework of recommendations for digital transmission systems, general aspects of interfaces	G.701-G.703
Coding of analogue signals; PCM of voice frequencies, performance of PCM channels at audio frequencies	G.711-G.712
Hypothetical reference digital paths	G.721
PCM multiplex equipment for voice frequencies of 2048 kbps, 1544 kbps	G.731-G.734
Second-order multiplex equipment for operating at 6312 kbps, 8448 kbps and using positive/zero/ negative justification	G.751-G.752
Higher-order multiplex equipment for operating at the third-order bit rate of 34368 kbps and fourth-order bit rate of 139264 kbps	G.751-G.752
Organization of digital networks; Plesiochronous operation of international digital links	G.811
Cable systems operating at 8448 kbps	G.911

Table B.1-9. CCITT Q-Series Recommendations

Scope and Subject Description	Recommendation
(Telephone Switching and Signalling)	
Signalling and switching in automatic and semi-automatic services; numbering plan, dialing procedures, routing plan for international services	Q.10-Q.13
Power limies of signals, signalling frequencies, signalling in-band and out-band, miscellaneous	Q.15-Q.33
Clauses applicable to CCITT standard systems; numbering used, sending finished signal, one-way or both-way operation of international circuits, transmission of answer signal, facilities provided	Q.101-Q.109
Signalling on PCM links, clauses common to signal receivers for signalling systems	Q.110-Q.114
Control of echo suppressors, abnormal conditions	Q.115-Q.118

Table B.1-10. CCITT V-Series Recommendations

Scope and Subject Decription	Recommendation
(Data Transmission Over Telephone Network)	
General; power levels over telephone lines, international alphabet No. 5, standardization of data signalling rates	V.1-V.6
Interfaces and voice-band modems; balanced double-current interchange circuits, acoustic coupling, single-current interchange circuits, automatic calling and answering equipment, modems for several different rates	V.10-V.11 V.15-V.31
Wideband modem; modems and data transmission using 60-108 KHz group band circuits	V.35-V.36
Error control; error indication, code-independent error control system	V.40-V.41
Transmission quality and maintenance; standard limits for transmission quality, organization of the maintenance, data test set, loop test devices for modems, error-rate measuring apparatus, characteristics of distortion	V.50-V.57

B.2 REGIONAL REGULATORY BARRIERS

This section reviews the regional standard, EURCOM D/1, which may have impact on the DCS III system design in Europe. This review will be limited to system parameters directly related to the design of transmission links. Standards related with end-line equipment and message formats therefore are not examined in detail, and only the most pertinent characteristics are addressed.

B.2.1 EUROCOM

Formed by the European countries belonging to NATO, EUROCOM is intended to standardize operational characterstics of equipment manufactured in Europe, thus rendering such equipment compatible when the military forces of NATO operate under a unified command system. EUROCOM D/1 (Ref. B-4) is concerned only with trunk communication systems for combat zones.

A principal EUROCOM objective is to define technical characteristics for both the gateways and international access links in such a manner that neither special hardware nor special software will be required at the trunk links other than that required to support similar national links.

B.2.2 Network Configuration

The trunk communication system for the combat zone will be automatically switched with the digital grid system formed by interconnection of national networks. The system will provide four-wire traffic circuits from subscriber to subscriber capable of carrying voice, egraph, data, or facsimile traffic, and will recognize and handle three precedence levels of direct traffic.

The multi-channel trunk links between EUROCOM trunk networks of different nations are known as "gateways." Multi-channel connections between EUROCOM equipment of one nation and a EUROCOM network of another nation are known in "international access links."

Security within the system will be provided on a link-by-link basis. Radio relay and SCRA (single-channel radio access) links will always be protected by encryption. Line links may be protected by encryption or may be physically-secure circuits.

A typical network configuration is shown in Figure B.2-1 and an example of equipment layout is shown in Figure B.2-2 (see Figure B.2-3 for legend). Relevant connection and switching facilities are indicated in Table B.2-1. A particular network will not necessarily incorporate all equipments and facilities shown.

B.2.3 EURCOM Hypothetical Reference Circuit

B.2.3.1 General. Parameters of the EUROCOM Hypothetical Reference Circuit (HRC) are defined to provide a consistent basis for related design activities, including signalling, synchronization, and radio and cable transmission.

B.2.3.2 Requirement. To achieve adequate voice intelligibility the end-to-end error rate on a 16/32-kbps circuit is required to be less than 1 in 100. For circuits involving only static subscribers, the foregoing error rate will be realized for 99 percent of any one minute. In the case of circuits involving SCRA subscribers, the foregoing error rate will be realized for 95 percent of any one minute.

A less stringent requirement has not been stipulated for 32-kbps circuits in the above. Although 32-kbps channels are inherently more resilient to the effect of errors, it is expected that all circuits will involve 16-kbps links and ultimately will be entirely composed of 16-kbps links.

Error correction will be applied on an end-to-end basis to the connection specified above to meet user error-rate requirements for telegraph and data, as necessary. Therefore only the voice requirement is considered in establishing the parameters of the hypothetical reference circuit.

B.2.3.3 Hypothetical Reference Circuit. The EUROCOM Hypothetical Reference Circuit (HRC) is shown in Figure B.2-4 and the allowable contributions to the overall circuit error rate by the component links of the HRC are specified in Table B.2-2. The largest contribution have been assigned to SCRA links, as these normally will not be engineered.

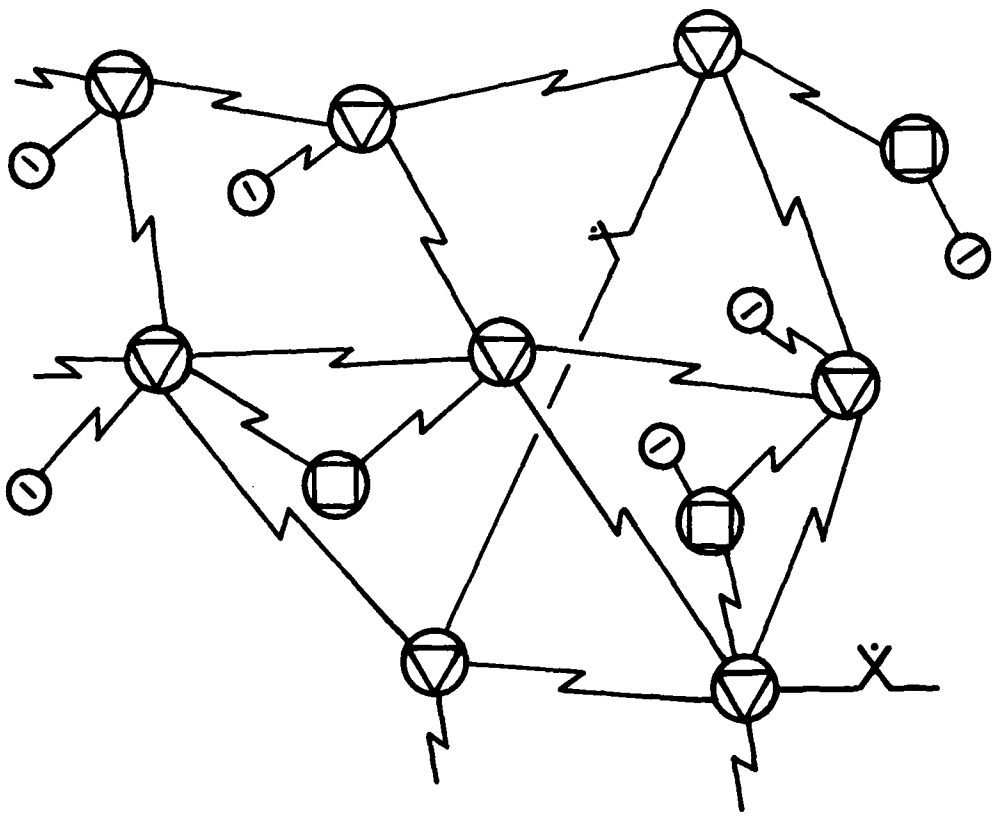


Figure B.2-1. Example of Network Configuration
(See Figure B.2-3 for Legend)

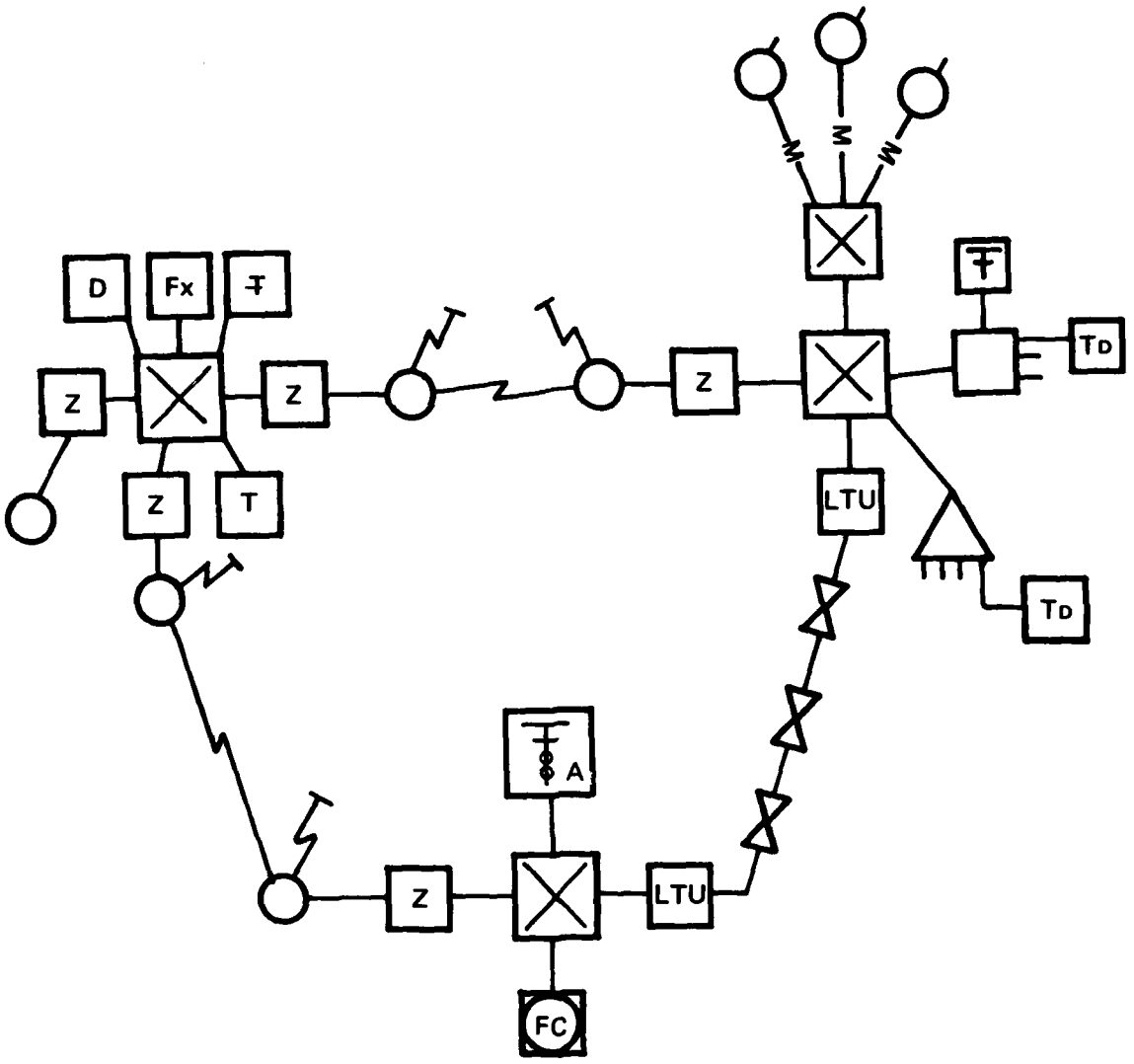


Figure B.2-2. Example of Equipment Layout
(See Figure B.2-3 for Legend)

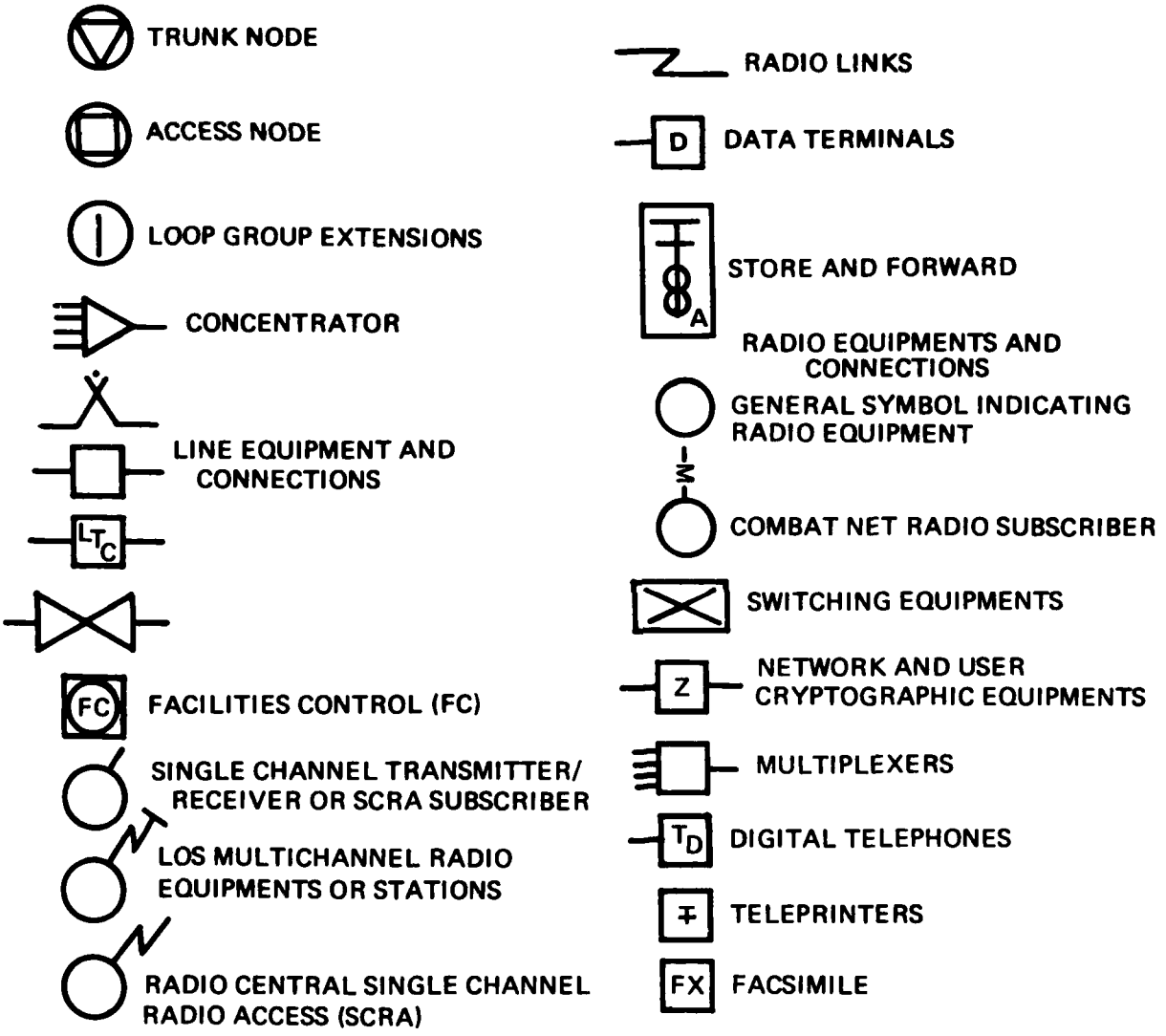


Figure B.2-3. Definition of Legends for Figures B.2-1 and B.2-2

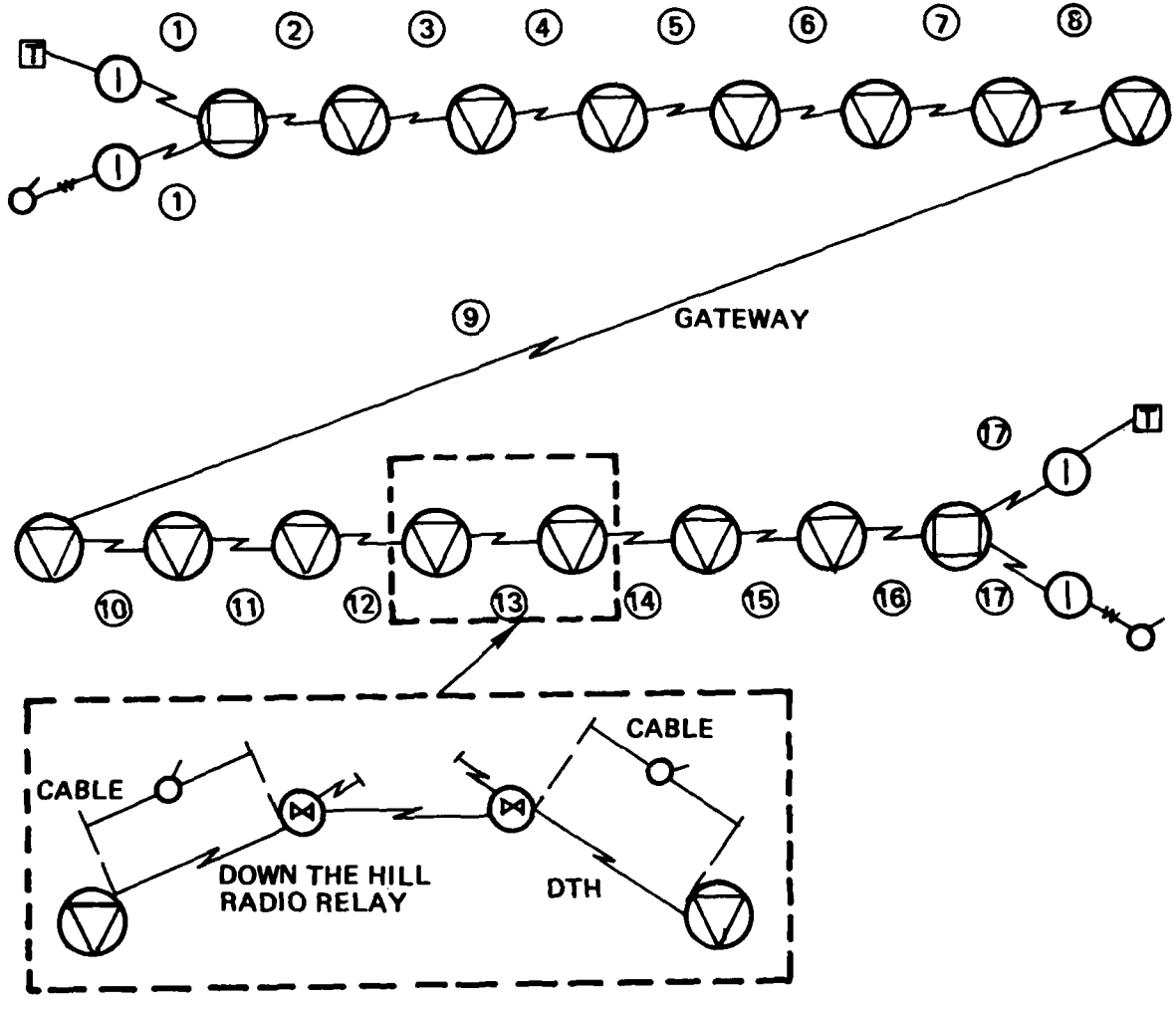


Figure B.2-4. EURCOM Hypothetical Reference Circuit

Table B.2-1. Network Configuration and Switching Facilities

	a. Trunk Node	b. Access Node	c. Radio Access Point (with Switching Facility)	d. Concentrator Access Point	e. Multiplex Access Point (Loop Group Extension)	f. Radio Access Point (No Switching Facility)
Connection Facilities						
Trunk Group	Trunk group for connection with: - other trunk nodes - access nodes - radio access points as c.	1, 2 or 3 trunk groups for connection with: - trunk nodes	None	None	None	None
Loop Group	1 or more loop groups for connection with: - concentrator access points - multiplex access points - radio access points as f.	As trunk node	One loop group to connect: - trunk node - access node	One loop group to connect: - trunk node - access node	As concentrator access point	As concentrator acce:, point
Single Channel	Local (wire) subscribers	As trunk node	Radio subscribers	Local (wire) subscribers. Number of connected subscribers can be greater than loop group capacity	Local (wire) subscribers. Number of subscribers connected not greater than loop group capacity	
Switching Facilities	Trunk group channels to trunk group channels Trunk group channels to loop group channels Trunk group channels to single channels Loop group channels to loop group channels Loop group channels to single channels Single channels to single channels	As trunk node without the facility to connect trunk group channels to trunk group channels	Trunk group channels to single radio channels Single radio channels to single radio channels	None	None	None
Registered Subscribers	Local subscribers directly connected to the trunk node Subscribers connected to: - access nodes - radio access points - concentrator access points - multiplex access points	As trunk Node	Radio subscribers directly connected to the radio access point. Updated subscriber is transmitted to parent trunk node. The exact subscriber registering depends on the final radio access system selected	None (registering on parent node)	None (registering on parent node)	None (registering on parent node)

Table B.2-2. Operational Error Rates on Hypothetical Reference Circuit

Circuit Type	Maximum Number of Circuits	Total Contribution		Contribution/Circuit	
		Error Rate	Percent of 1 Minute	Error Rate	Percent of 1 Minute
SCRA	2	80 in 10^4	95	4 in 10^3	95
Radio Relay	17	17 in 10^4	99	1 in 10^4	99
DTH Radio	34	34 in 10^5	99	1 in 10^5	99
DTH Cable	34	34 in 10^6	99.9	1 in 10^6	99.9
Cable Access	2	2 in 10^6	99.9	1 in 10^6	99.9

Note: Cited operational error rates of the Hypothetical Reference Circuit are specified without error correction and encryption devices.

Radio-relay and DTH radio links will be engineered with sufficient signal-strength to provide error rates of 1 in 10^4 and 1 in 10^5, or better. It is assumed the signal-strength margin employed will ensure that the foregoing error rates will be exceeded for less than 1 percent of any one minute in the presence of fading or impulse noise. It also should be assumed that a ground link between two nodes will be taken out of service when the average error rate on the link rises above 1 in 10^3 for a period in excess of five minutes.

B.2.4 Bit Rate, Frame Structure, and Multiplexing Method

B.2.4.1 Bit Rate. Single-Channel bit rates for the interim period and the ultimate solution are summarized in Table B.2-3.

Table B.2-3. HRC Single-Channel Bit Rates Summary

Applicable Time Frame	Static-Subscriber Channel Bit Rate (kbps)	Radio-Subscriber Channel Bit Rate (kbps)
Interim Period	32 16	To be agreed
Ultimate Solution	16	16

If different channel bit rates must be interconnected, the terminals with 32-kbps (and single-channel crypto equipment, if employed) will be switched to operate at 16-kbps and the terminals with 16-kbps will duplicate each bit for transmission within the 32-kbps network. The signalling procedure required to change the mode of operation from 32-kbps to 16-kbps and vice versa at the subscriber terminal is specified in Chapter ID, Section 3, of EUROCOM D/1. Single-channel clock synchronization will be accomplished by slaving the subscriber clock to the clock of the parent node.

Trunk bit rates for the interim period and the ultimate solution are summarized in Table B.2-4.

Table B.2-4. Trunk Bit Rates Summary

Applicable Time Frame	Single-Channel Bit Rate (kbps)	Trunk Bit Rate (kbps)	Bit Slots per Frame
Interim Period	16	256	16
		512	32
		1,024	2x32*
	32	512	16
		1,024	32
Ultimate Solution	16	256	16
		512	
		1,024	2x32*

*Obtained by combining two 512 kbps bitstreams

B.2.4.2 Frame Structure. The frame structure is summarized in Table B.2-5.

Table B.2-5. Frame Structure Summary

Bit Slots per Frame	Channel	Allocation
16	1	Frame alignment
	2	Signalling
32	1	Frame alignment
	2	Signalling
	3 to 32	Information
2 x 32	1a	Frame alignment
	1b	Frame alignment
	2a	Signalling
	2b	Signalling
2 x 32	3a to 32a	Information
	3b to 32b	Information

Note: Channels 1a, 2a, etc. are from system "a". Channels 1b, 2b, etc. are from system "b". Frame alignment patterns are identical in both systems "a" and "b".

B.2.4.3. Multiplexing. The multiplexing method adopted is cyclic bit interleaving (bit-by-bit).

B.2.5 Transmission Media.

B.2.5.1 Radio Relay. The following data characterize certain pertinent parameters of radio-relay and cable transmission. Mobile radio-relay equipment will transmit in the following frequency bands (MHz), and frequency ranges in other bands are under study.

- Belgium: 225-400, 610-960, 1350-2700
- France: 160-400, 400-960, 1350-2700, 4400-5000, 4400,5000,
- Italy: 225-400, 610-960, 1350-1850, 4400-5000,
- Netherlands: 225-400, 610-960, 1350-1850, 4400-5000,
- United Kingdom: 225-400, 610-960, 1350-1850, 4400-5000.

It also is possible to set the frequency of RF channels at the following multiples:

- 0.125 MHz in 225-400 MHz band
- 0.125 MHz (or 0.250 MHz, as secondary choice) in 610-960 MHz band
- 0.250 MHz in 1350-1850 MHz band
- 0.500 MHz in 5500-5000 MHz band.

Transmitters will accept digital inputs in bipolar form at 256, 512 and 1024 kbps for transmission as 256, 512, and 1024-kbps FM signals.

Receivers for 1024-kbps signals will use biternary detection in accordance with the following detection rule:

Biternary Sample	Binary Output Signal
+1	1
0	Inversion of the preceding bit
-1	0

Frequency shaping at the transmitter and at the receiver are specified by EUROCOM D/1, Chapter IB, Section 5.

B.2.5.2 Cable. The signal at the line interface will be that encountered at the output of the line of the terminating unit or of the repeater. For transmission on balanced pairs, the HDB3 line code will be used.

The pulse shape may be either "rectangular" or "half-sinewave." Both shapes may be used in the same link provided that the spacing between repeaters of different types is somewhat smaller than the normal spacing between repeaters of a similar type.

Pulse characteristics for both rectangular pulses and half-sinewave pulses are given in EUROCOM D/1, Chapter IB, Section 5. Section 6 identifies the interconnection points and the signals at those points.

B.2.6 Radio Relay Parameters

The agreed gateway parameters are shown in Table B.2-6. The transmitter and receiver parameters according to present national intention are given in Tables B.2-7 and B.2-8 for interim and ultimate gateway solutions respectively. The premodulation filter response, IF filter amplitude response, and post detection filter response are shown in Figures B.2-5, B.2-6, and B.2-7 respectively.

B.2.7 Access Link Parameters

Parameters for access links according to present intentions are the following:

- 225-400 MHz and 610-690 MHz (Tables B.2-7 and B.2-8)
- 1350-1850 (Table B.2-9)
- 4400-5000 MHz (Table B.2-10)
- 14.4-15.3 (To be developed).

Table B.2-6. Agreed Gateway Parameters

Single-Channel Bit Rate (kbps)	32	16
Trunk Capacity (Channels)	16	16
Trunk Bit Rate (kbps)	512	256
Frequency Bands (MHz)	610-960 (225.400) x	610-960 (225.400) x
Frequency Setting (MHz)	0.125 (0.250) xx	0.125 (0.250) xx
Path Loss Capability for BER + 10^{-4} (db)	142	145
Transmitter Occupied Bandwidth (99%) (KHz)	750	500
Antenna Polarization	Plan horiz (Vert) x	Plan horiz (Vert) x
Modulation Method	Binary FM	Binary FM
EOW Bit Rate kbps	16	16
EOW Modulation Method	Additive binary binary	Additive
EWO Modulation Depth	18 percent of traffic	18 percent of traffic

x = Secondary choice
xx = Secondary choice in 610-960 MHz band

Table B.2-7. Transmitter and Receiver Parameters According to Present National Intentions for the Interim Gateway Solution (Mode 512 kps) (Continued)

Parameters		225-400 MHz			610-960 MHz		
		BE	FR	US	BE	FR	US
Transmitter	Premodulation filtering (3 dB bw) (kHz)	460	250	480	480	500	480
	Deviation ratio ($\frac{\text{peak to peak dev}}{\text{bit ratio}}$)	0.62	0.31	1.17	0.62	0.62	1.17
	Output RF power (dBm)	40	42	37	40	37	38
	Feeder loss (dB)	3.5	2.5		6	3.0	
	Antenna gain, w.r.t. isotropic (dB) (min and max)	9-12.5	10-12	7-10	15-17.5	15-17	12
Receiver	Antenna gain, w.r.t. isotropic (dB) (min and max)	9-12.5	10.12	7-10	15-17.5	15-17	12
	Feeder loss (dB)	3.5	2.5		6	3.0	
	Min acceptable receiver input for 10^{-4} BER (dBm)	-91	-88	-91	-91	-68	-91
	Receiver noise figure (dB)	7.5	6	8	7.5	7	9
	IF filter (equivalent noise band-width) (kHz)		750	750		750	750
	Post detection filtering (3 dB bw) (kHz)		150	410		400	410
	Feeder length (m)	25	25		25	25	

Table B.2-7. Transmitter and Receiver Parameters According to Present National Intentions for the Interim Gateway Solution (Mode 512 kbps)

Parameters		225-400 MHz				610-960 MHz			
		GE	IT	NL	UK	GE	IT	NL	UK
Transmitter	Premodulation filtering (^{0}) (3dB bw) (kHz)	400	320	480	490	400	320	460	490
	Deviation ratio ($\frac{\text{peak to peak dev}}{\text{bit ratio}}$)	0.63	0.65	0.70	0.32	0.63	0.65	0.70	0.32
	Output RF power (dBm)	40	40	40	40	38	36	40	40
	Feeder loss (dB)	0	1.5	3.5	2.5	0	2.5	6	4.2
	Antenna gain, w.r.t. isotropic (dB) (min and max)	10	10.5	11.0	10.0	17	15	16	15-17.5
Receiver	Antenna gain, w.r.t. isotropic (dB) (min and max)	10	10.5	11.0	10.0	17	15	16	15-17.5
	Feeder loss (dB)	0	1.5	3.5	2.5	0	2.5	6	4.2
	Min acceptable receiver input for 10-4 BER (dBm)	-98	-95	-96	-91	-98	-95	-96	-91
	Receiver noise figure (dB)	8	7	7	7.5	8	7	7	7.5
	IF filter (equivalent noise band width) (kHz)	580	600		610	580	600		610
	Post detection filtering (3 dB bw) (kHz)	280	520		280	280	520		250
	Feeder length (m)	0		25	27	0		25	27

Table B.2-8. Transmitter and Receiver Parameters According to Present National Intentions for the Ultimate Gateway Solution (Mode 256 kbps)

Parameters		225-400 MHz			610-960 MHz		
		GE	IT	UK	GE	IT	UK
Transmitter	Premodulation filtering (^{0}) (3dB bw) (kHz)	240	160	230	240	160	230
	Deviation ratio ($\frac{\text{peak to peak}}{\text{bit rate}}$)	0.66	0.74	0.9	0.66	0.74	0.9
	Output RF power (dBm)	40	40	40	38	38	40
	Feeder loss (dB)	0	1.5	2.5	0	2.5	4.2
	Antenna gain, w.r.t. isotropic (dB) (min and max)	10	10.5	10	17	15	15-17.5
Receiver	Antenna gain, w.r.t. isotropic (dB) (min and max)	10	10.5	10	17	15	15-17.5
	Feeder loss (dB)	0	1.5	2.5	0	2.5	4.2
	Min acceptable receiver input for 10^{-4} BER (dBm)	-101	-101	-99	-101	-101	-99
	Receiver noise figure (dB)	8	7	7.5	8		7.5
	IF filter (equivalent noise band width) (kHz)	580	300	610	580	300	610
	Post detection filtering (3 dB bw) (kHz)	1st 200 2nd 210	260	180	1st 280 2nd 210	260	180
	Feeder length (m)	0		27	0		27

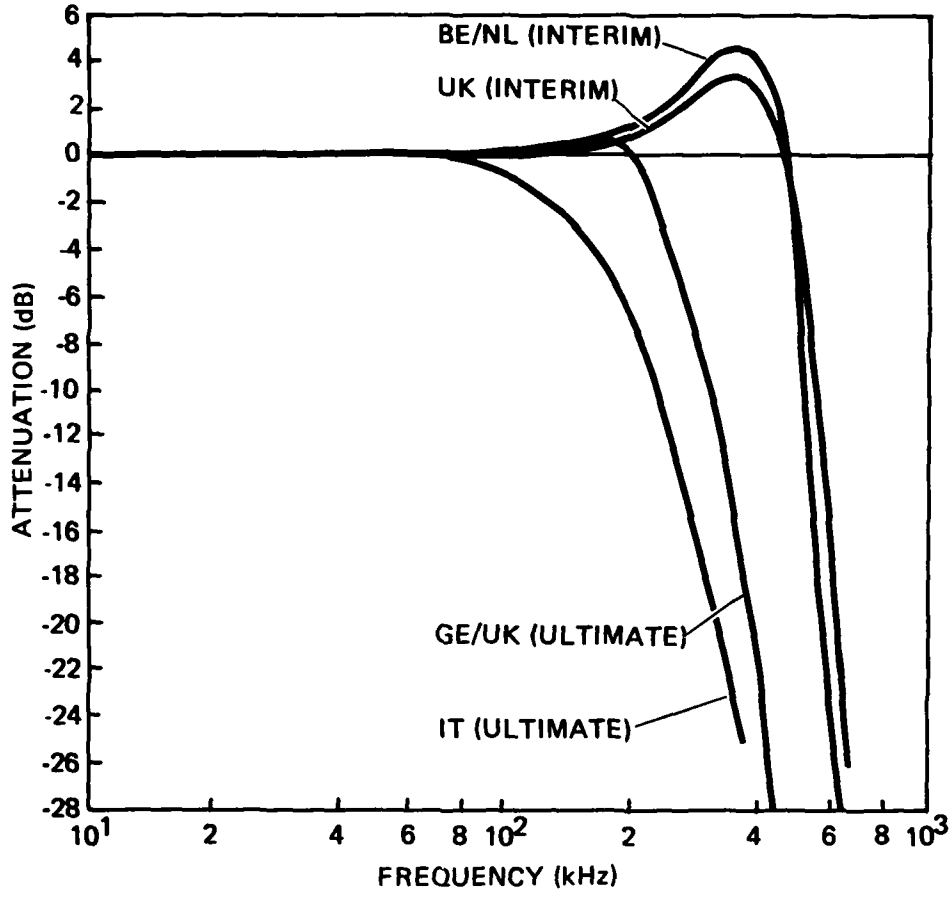


Figure B.2-5. Premodulation Filter Response

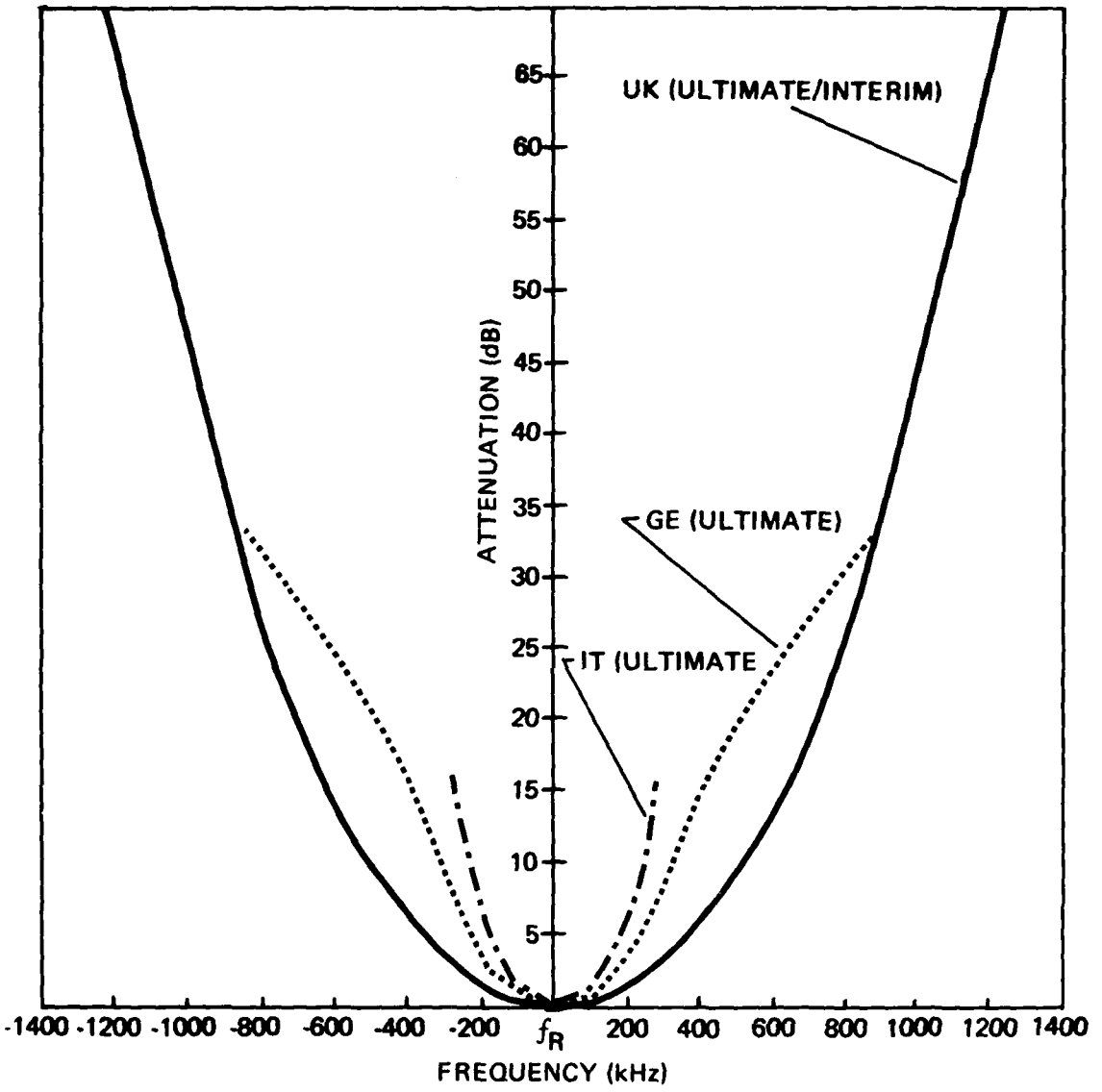


Figure B.2-6. IF Filter Amplitude Response

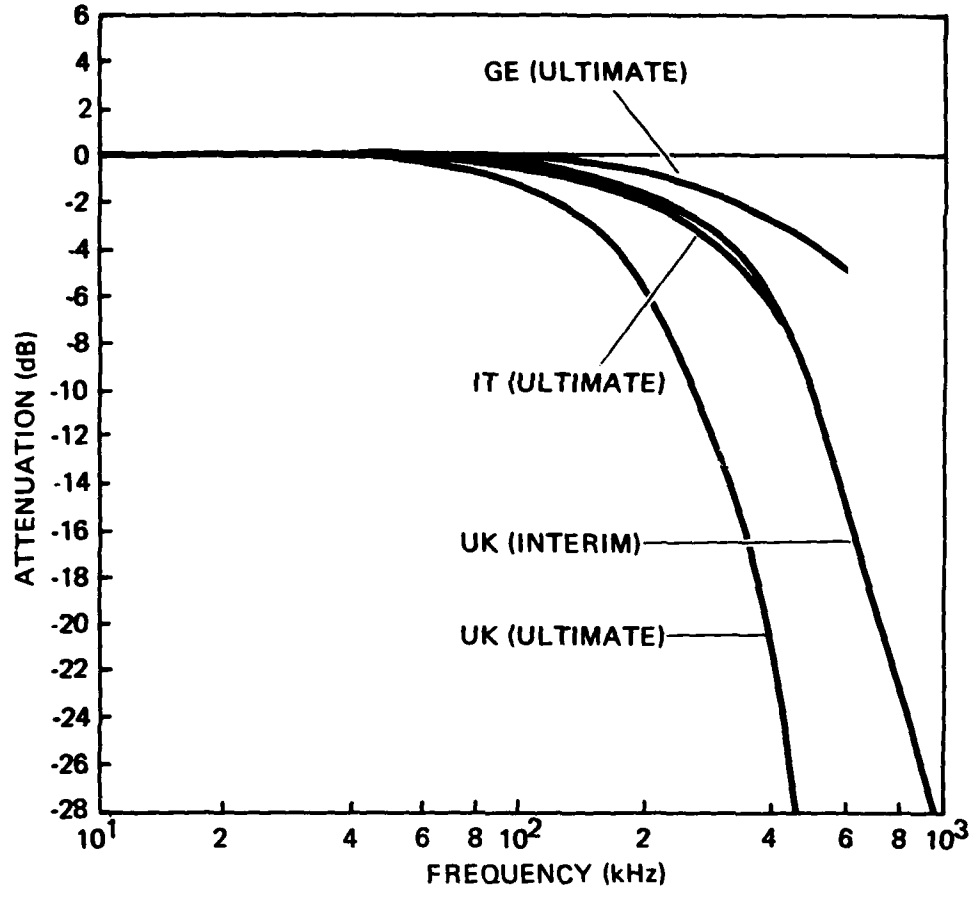


Figure B.2-7. Post Detector Filter Response

Table B.2-9. Radio Relay Parameters Band 1350 - 1850 MHz

	BE	FR	GE	IT	NL	UK	US
Single Channel Bit Rate (kbit/s)	48	48	(32) 16	(32) 16		(32) 16	
Trunk Cap. (Channels	12/24	24	16	16/32		16	
Trunk Bit Rate (kbit/s)	576/1152	1152	(512) 256	(512/1024) 256/512		(512) 256	576/1152
Freq. Setting (MHz)	0.125		0.125	0.250		0.250	1.00
Path Loss Cap. for BER=10^{-4} (dB)	126/120					(151) 159	150
Occ. Bandwidth tx. 99% (MHz)	0.90/1		(≤0.75) ≤0.50			0.50	
Polarization (Antenna)	H/V		H/V			H/V	
Mod. Methode	bin/ bitern FM		binary FM	(bin/duob) binary		binary FM	bin/ bitern. FM
Premod. Filter tx (MHz)	0.5		(0.40) 0.24			0.49	
Deviation Ratio	0.62/0.31		(0.63) 0.66	0.6-0.8		(0.32) 0.9	0.62/0.31
Output Power (dBm)	30.8 min.		31	37		31-32	39
Feeder Loss (dB)			0			5.5-7.5	
Antenna Gain (isotr) (dB)	22-23		21-23			19.5-23	
Min.Rec.Input for BER=10^{-4} (dBm)	-95 °) -89 °°)		(-98) -101			(-90) -98	
Noise Fig. (dB)	8.5		8	≤8		8.5	12
IF Filter Bandwidth (MHz)	0.66		0.580			0.610	
Detect. Methode	ID		ID			ID	
Post Filter Bandwidth (MHz)			(0.28) 0.21			0.21	
Feeder Length (m)			0	≤27		27	
Freq. Band (MHz)	1350- 1850		1400- 1660	1350- 1850		1350- 1850	

(°) interim, (°°) for 576 kbit/s, (°°) for 1152 kbit/s, NL has not yet specified

Table B.2-10. Radio Relay Parameters Band 4400 - 5000 MHz

	BE	FR	GE	IT	NL	UK	US
Single Channel Bit Rate (kbit/s)		48				16	
Trunk Cap. (Channels)		24		12/24/120		16/32	
Trunk Bit Rate (kbit/s)		1152		576/1152		256/512	2304/4608
Freq. Setting (MHz)		0.125		0.500		0.100	0.100
Path Loss Cap. (dB)				180 (BER 10^{-6})		160-154 (BER 10^{-5})	174
Occ. Bandwidth tx. 99% (MHz)		4		0.7 576 (kbit/s)		0.5-0.7	
Polarization (Antenna)		crossed 45°		H/V		H/V	
Mod Methode		FDM/TDM		(FDM) TDM		TDM	
Premod. Filter ts. (MHz)							
Deviation Ratio				0.65			0.38
Output Power (dBm)				30		24	24
Feeder Loss (dB)				1.5		3.6-7.2	
Antenna Gain (isotr) (dB)						29	
Min.Rec.Input for BER=10^{-4} (dBm)							
Noise Fig. (dB)							5
IF Filter Bandwidth (MHz)							
Detection Methode							
Post Filter Bandwidth (MHz)							
Feeder Length (m)		25		15		15-30	
Freq. Band (MHz)		4400-5000		4400-5000		4400-5000	4400-5000

BE, GE, NL are not proposing SHF equipment for this purpose

B.3 NATIONAL REGULATORY BARRIERS

Section B.3 provides a general appraisal of pertinent aspects of frequency management and technical standards in the U.S. that are applicable to military communications, supplemented by brief discussions of regulatory barriers of Germany and Turkey.

B.3.1 U.S. National Regulatory Barriers.

In the United States, centralizing control for nongovernment stations is vested in the Federal Communication Commission (FCC), which was formed under the Communications Act of 1934. However, control of frequencies for stations belonging to and operated by the United States was conferred upon the President and until recently was exercised by the director of Telecommunications Management (DTM) acting on behalf of the President and through the Office of Telecommunications Policy (OTP). The OTP was advised by the Interdepartment Radio Advisory Committee (IRAC), a committee of representatives of those government agencies which were major users of radio. By Executive Order No. 12046 dated 26 March 1978 the functions of the director of Telecommunications Management and the OTP were abolished. These functions, once conferred on the President, were transferred to the Assistant Secretary of Commerce for Communications and Information. That order created the National Telecommunications and Information Administration (NTIS) with the Secretary of Commerce for Communications and Information as its administrator, and IRAC was subsequently combined with NTIA. Although NTIA has no control over military frequency assignments, military agencies are members of IRAC and therefore abide by frequency-management rules and procedures established by NTIA (Ref. B-5). (Because the FCC is only concerned with non-government stations, that agency is disregarded in this study.)

B.3.1.1 NTIA Organization and Scope. Figure B.3-1 displays general organization of the NTIA, and Figure B.3-2 indicates organization of the Office of Federal Systems and Spectrum Management, which holds responsibility for frequency management of government stations. Coordination with governmental departments and agencies, including the military and the FCC, is obtained through IRAC, which reports to the director of Spectrum Plans and Policies.

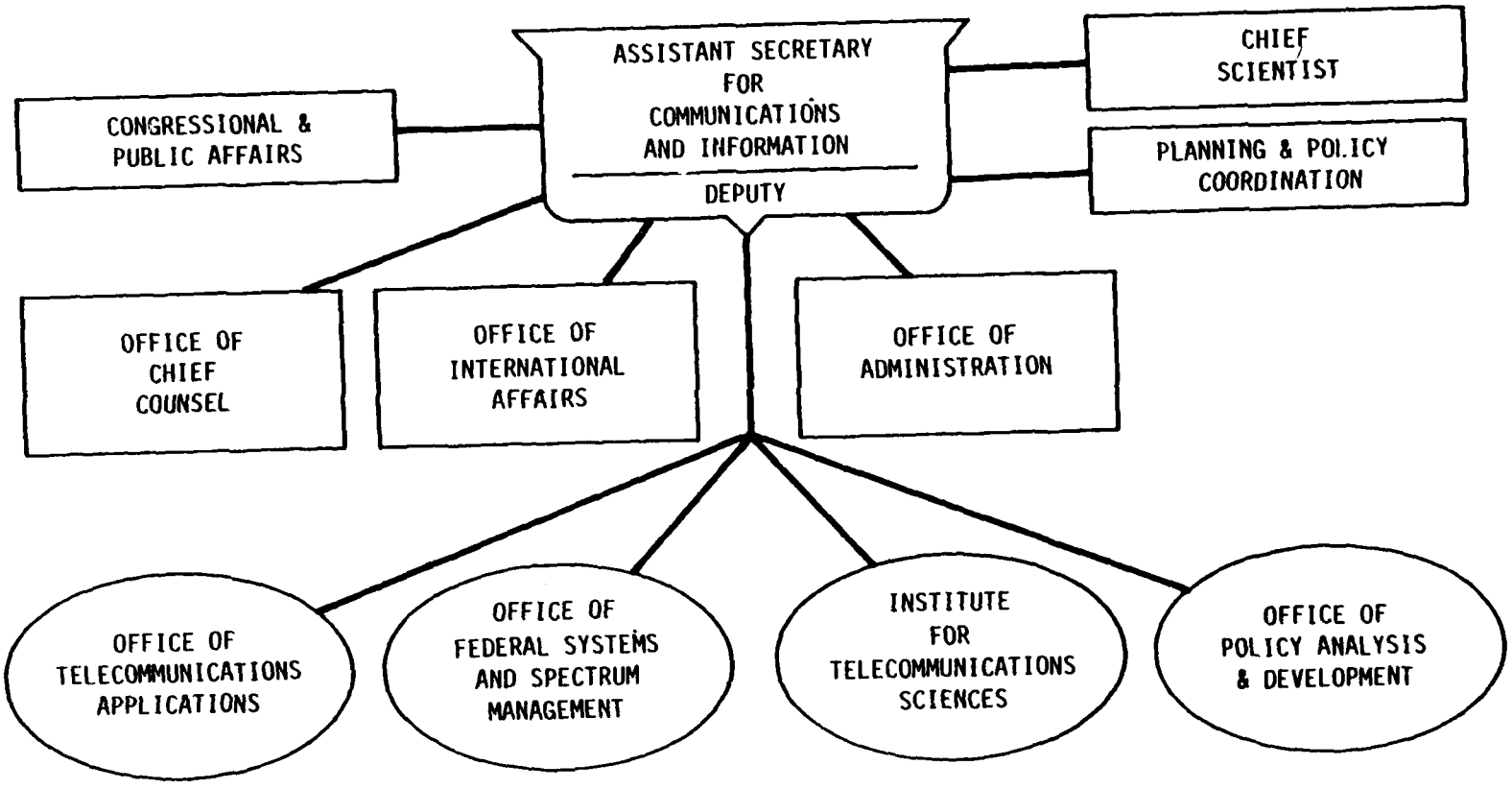


Figure B.3-1. General Organization of the NTIA

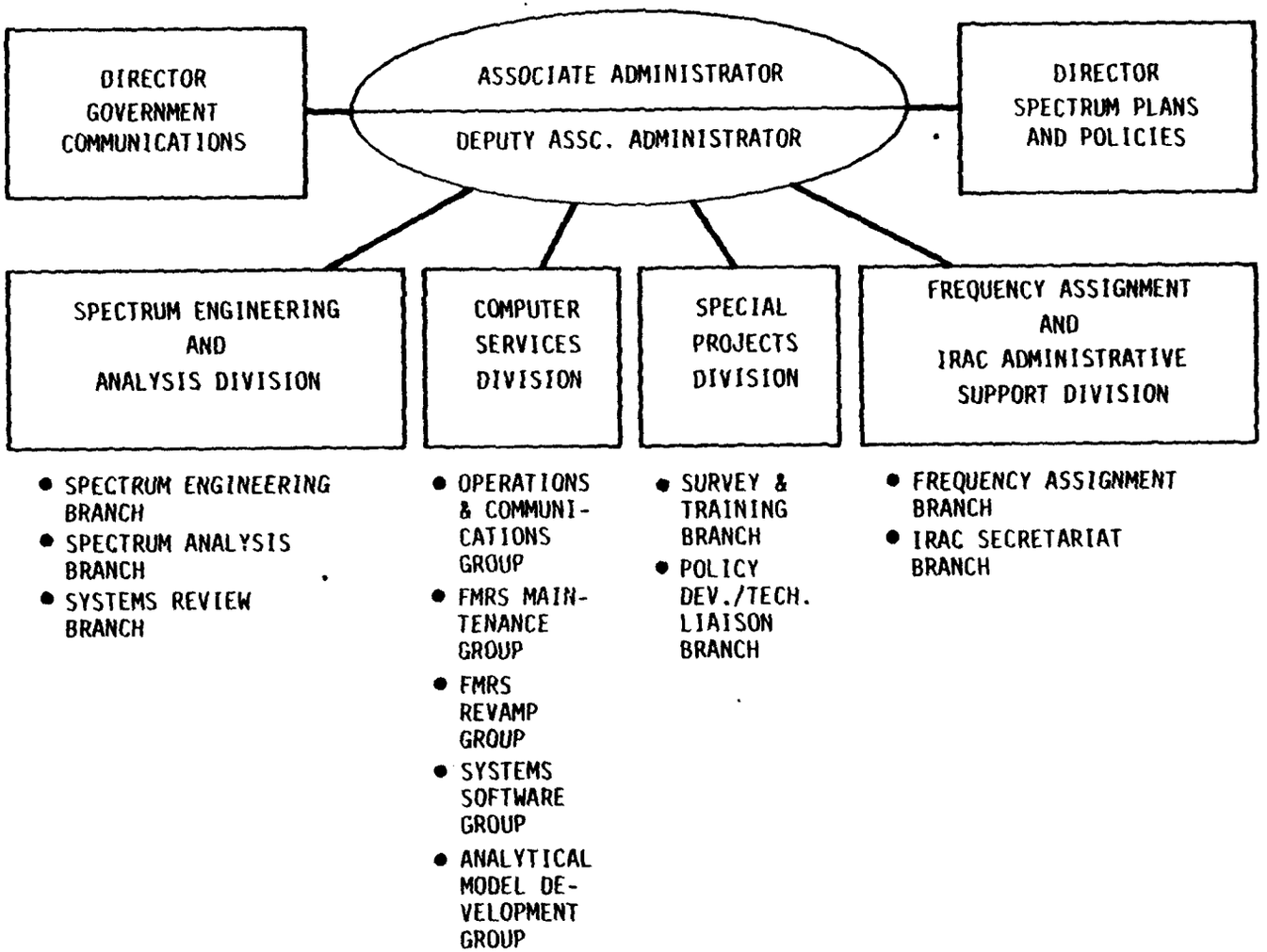


Figure B.3-2. Organization of the Office of Federal Systems and Spectrum Management

IRAC organization is shown in Figure B.3-3, liaison between IRAC and the FCC being conducted by a representative appointed by the FCC. The Basic IRAC functions are to aid the Assistant Secretary in assigning frequencies to U.S. Government radio stations and to develop and execute policies, programs, procedures, and technical criteria pertaining to allocation, management, and use of the spectrum.

Within IRAC, the Frequency Assignment Subcommittee (FAS) develops procedures for assignment of radio frequencies, and the Aeronautical Assignment Group (AAG) of FAS oversees certain frequency assignments in bands serving aeronautical mobile and aeronautical radio navigation. The Military Assignment Group (MAG) has similar authority over bands of primary concern to military users.

The Spectrum Planning Subcommittee (SPS) plans future allotments of the electromagnetic spectrum, taking into account established or anticipated radio services and the apportionment of spectrum space between government and non-government activities. The SPS addresses its responsibilities by the following action:

1. Maintains a continuing appraisal of the current and future needs of the various radio services and makes recommendations to IRAC for changes in the Table of Frequency Allocations, as appropriate.

2. Performs preparatory work relating to frequency allocation matters for international conferences.

3. Considers, develops, and defines approach and philosophy for addressing requirements anticipated in the following areas:

    - Current and planned uses of national and international frequencie and optimum placement of radio services.

    - Anticipated needs for all services and projected needs for periods 5, 10, 15, and 20 years ahead.

    - New developments in existing services.

    - New techniques which may require revision of Table of Frequency Allocations.

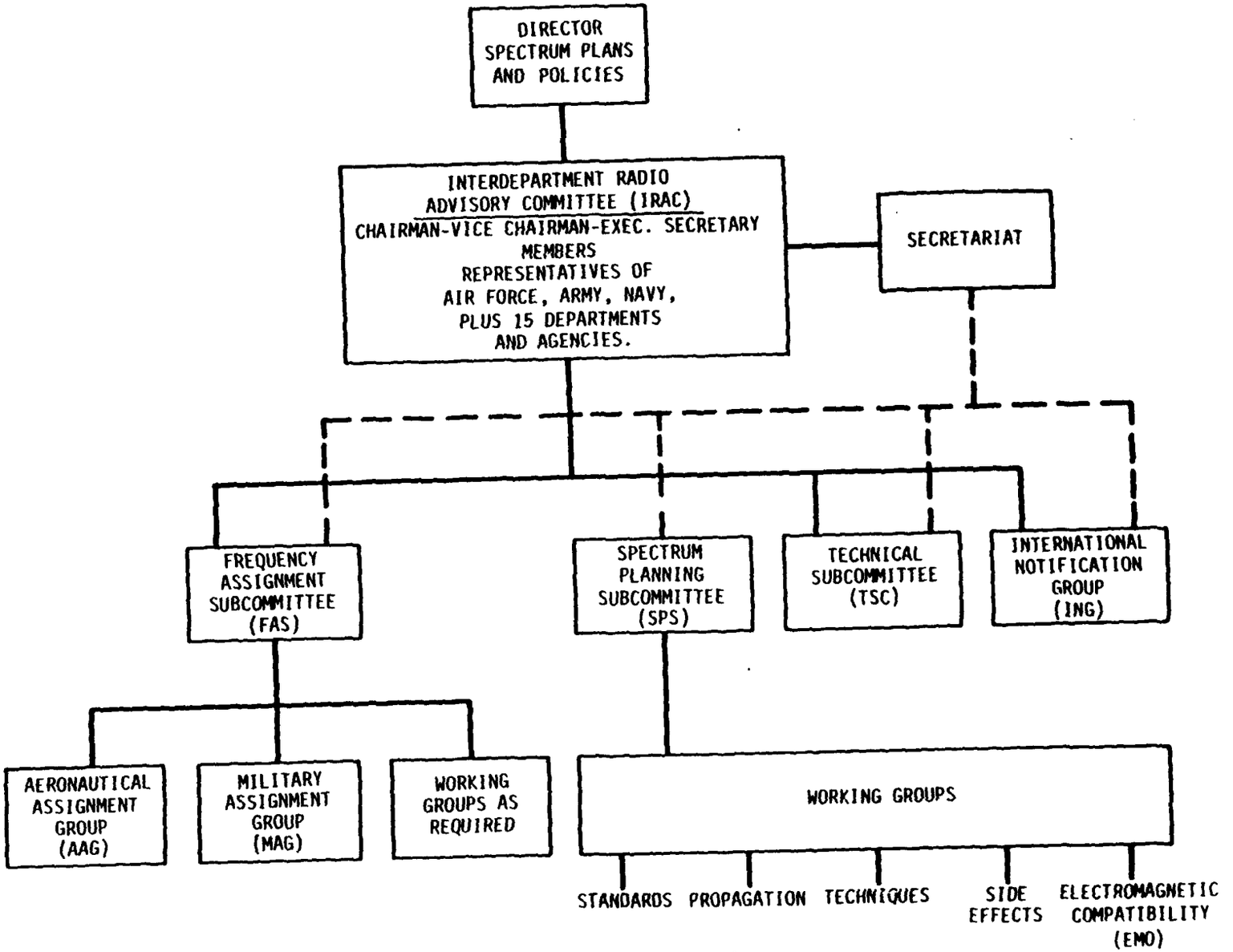


Figure B.3-3. IRAC Organization

- New techniques whose application may require revision of the allocated frequency bands, and the international impact of changes recommended to IRAC.

- New services for which Table of Frequency Allocation makes no provision.

4. Ensures electromagnetic compatibility among electronic systems by providing for the following:

   - Development and maintenance of pertinent documentation on all operational and planned satellite systems.

   - Identification of any incompatibility in new-system concept development.

   - Recommendation of potential electromagnetic compatibility problem areas and of proposed action for their resolution.

The Technical Subcommittee (TSC) is concerned with technical aspects affecting use of the electromagnetic spectrum and with other matters as IRAC may direct. TSC implements these functions by the following action:

1. Develops new standards to improve use of the radio spectrum.

2. Conducts radio propagation (including natural radio noise) programs to evaluate utilization of the radio spectrum and issues recommendations for better use of the spectrum.

3. Develops technical reports explaining new and existing techniques.

4. Provides coordination and evaluation related to the biological and nonbiological effects of non-ionizing electromagnetic radiation.

TSC activities are through the Propagation, Techniques, Side Effects, and Electromagnetic Compatibility working groups.

The International Notification Group (ING) prepares responses to the International Telecommunication Union concerning United States frequency assignments and their notification.

The three military agencies are represented in all subcommittees but have no representation on IRAC.

B.3.1.2 Frequency Management Structure for Military Forces. Within the Department of Defense, military-frequency planning, including joint-function frequency allocation, is conducted in a mutual military effort between the Joint Chiefs of Staff (JCS) and the Military Communication and Electronic Board (MCEB). However, final approval of frequency bands, operating modes, and equipment characteristics rests with the MCEB.

The Army, Navy, and Air Force have their own frequency-management structures, as shown in Figures B.3-4, B.3-5, and B.3-6. The DoD frequency management structure is shown in Figure B.3-7. Responsibility to prepare technical standards and spectrum-use policies is vested in the Deputy Assistant Secretary of Defense (DASD). The Electromagnetic Compatibility Analysis Center (ECAC) holds responsibility for ensuring compatibility of frequency assignments and advises the JCS, MCEB, and DASD. Because DoD is not a member of IRAC, coordination of policies established by the NTIA is effected by individial representatives of the Army, Navy, and Air Force, the purpose of which may be to gain three votes on the committee.

Although the Defense Communication Agency (DCA) performs system engineering for the Defense Communications System and ensures that DCS can meet long-term point-to-point and switched-network telecommunications requirements, DCA is not a member of IRAC and has no direct representative to influence frequency spectrum policies established by NITA. Inclusion of DoD as a member of the IRAC may become necessary in the future to ensure that military telecommunications requirements are adequately addressed by IRAC.

B.3.1.3 International Matters. All international communications matters are coordinated through the Telecommunication Division of the Department of State. Agencies acting for the United States are the FCC, IRAC, FAA, and the JCS. A list of sub-bands coordinated by each one of these agencies is contained in Part 3.4 of the Manual of Regulations and Procedures for Federal Radio Frequency Management (hereafter referred to as "NTIA Manual").

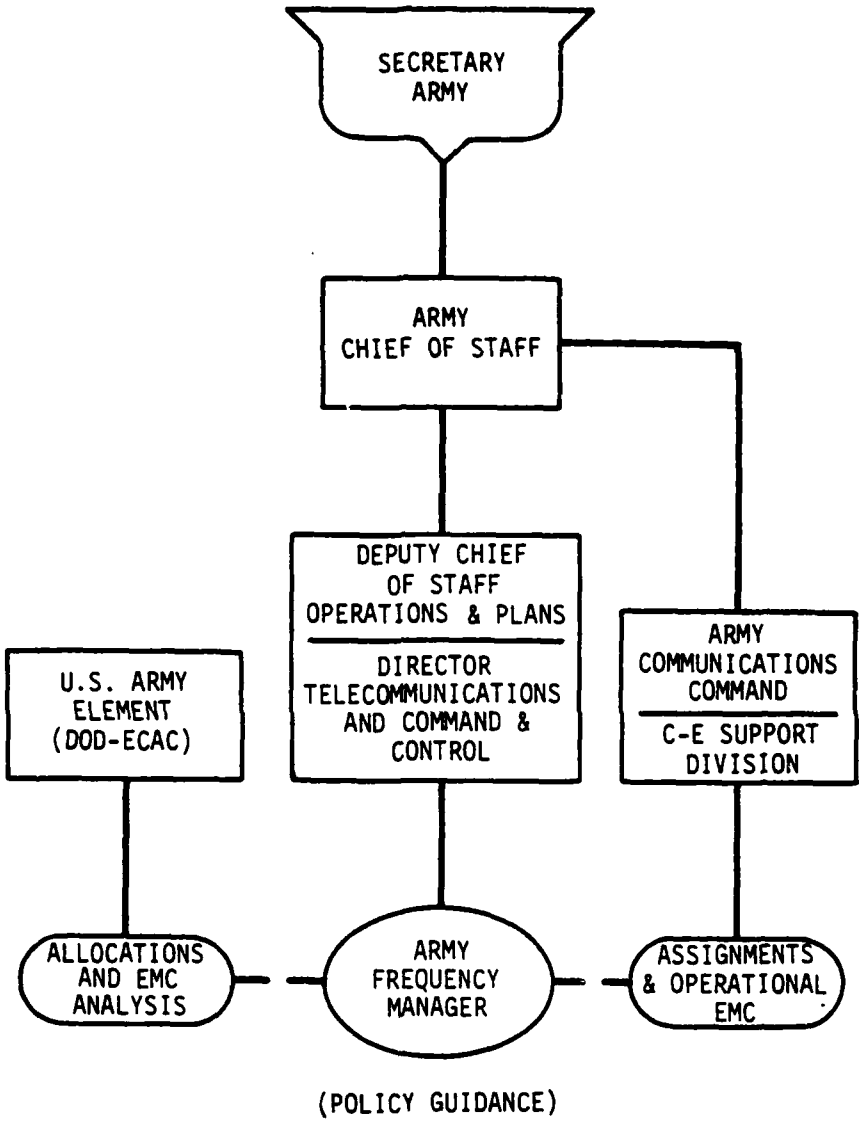


Figure B.3-4. Army Frequency-Management Structure

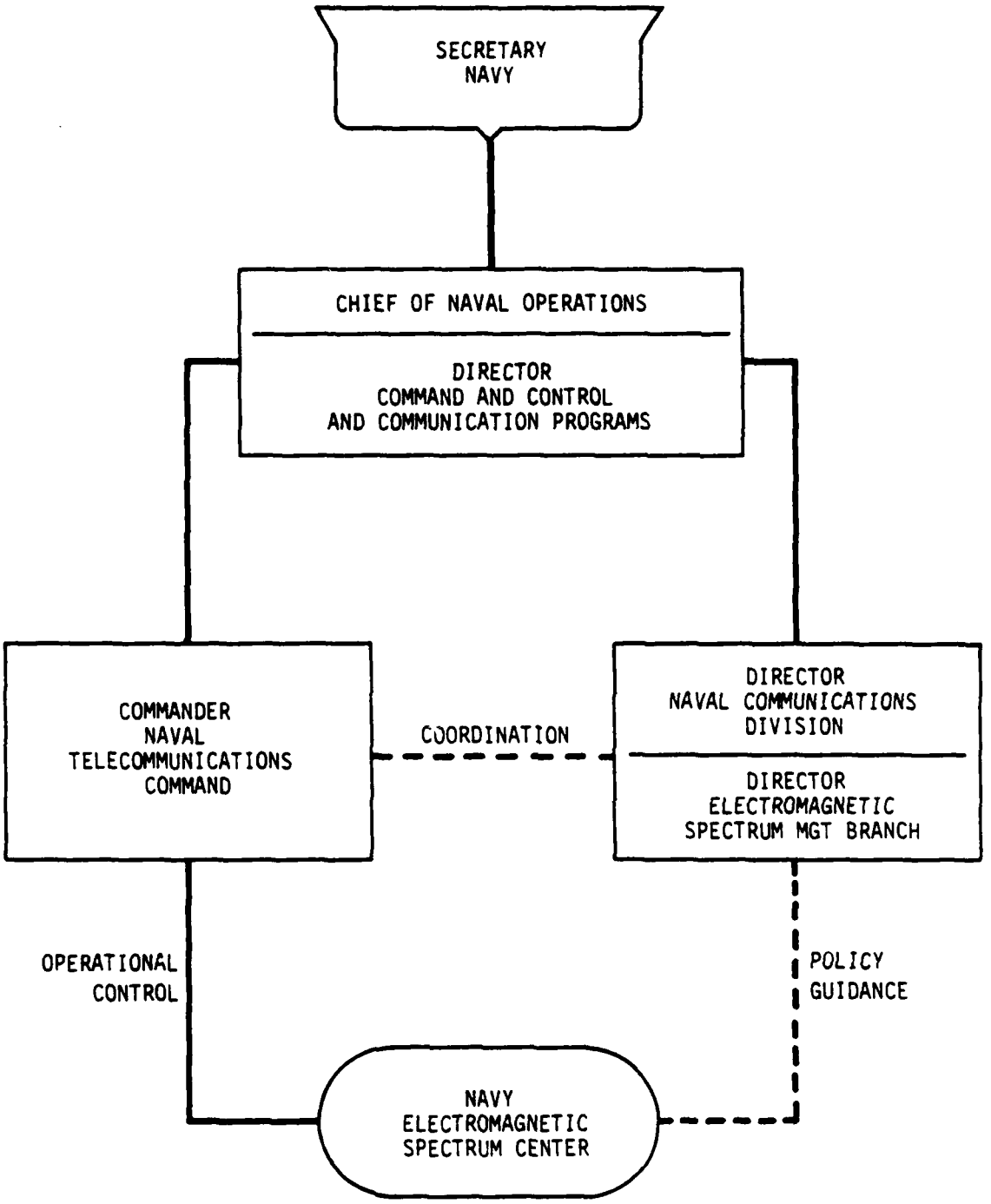


Figure B.3-5. Navy Frequency-Management Structure

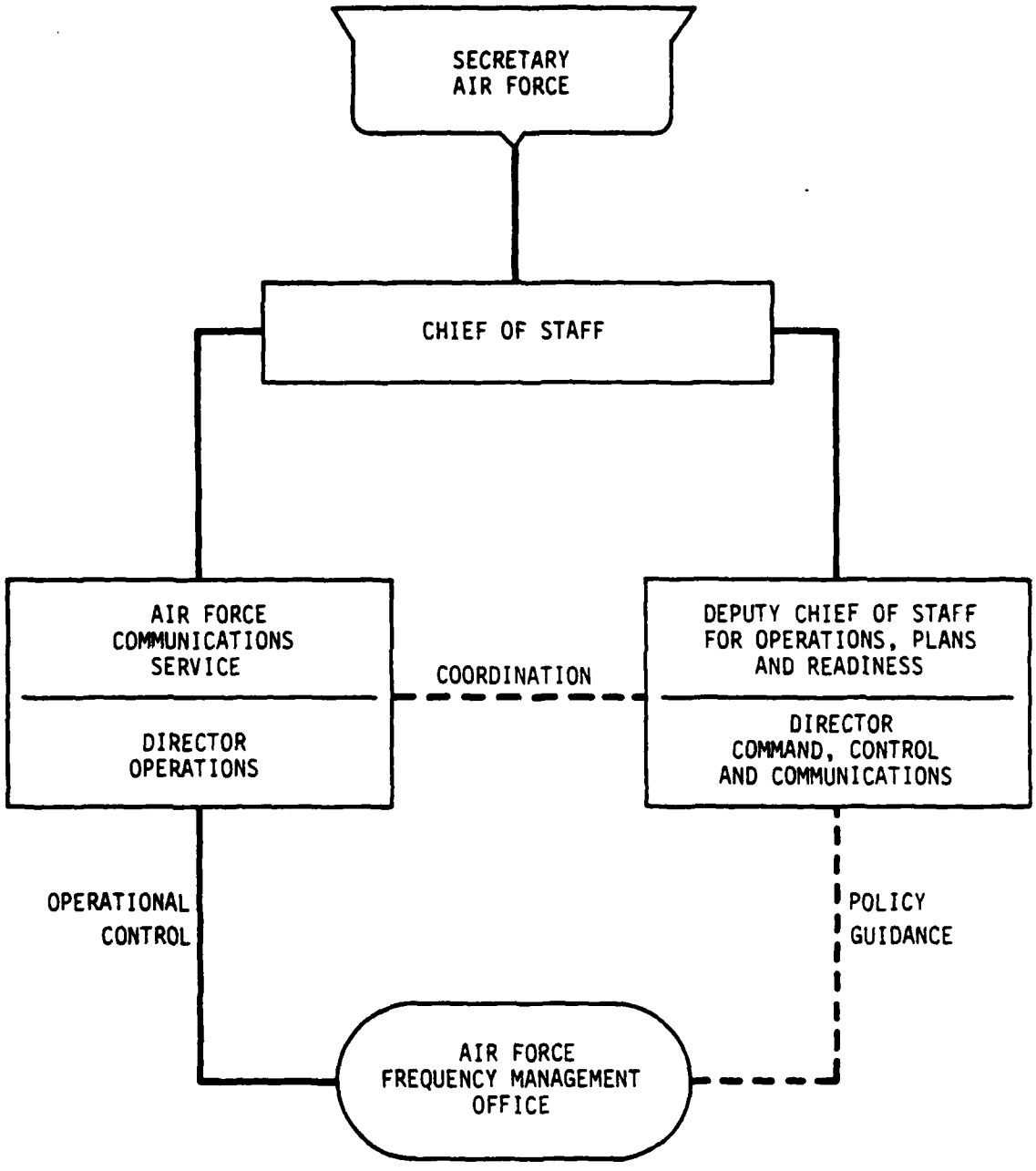
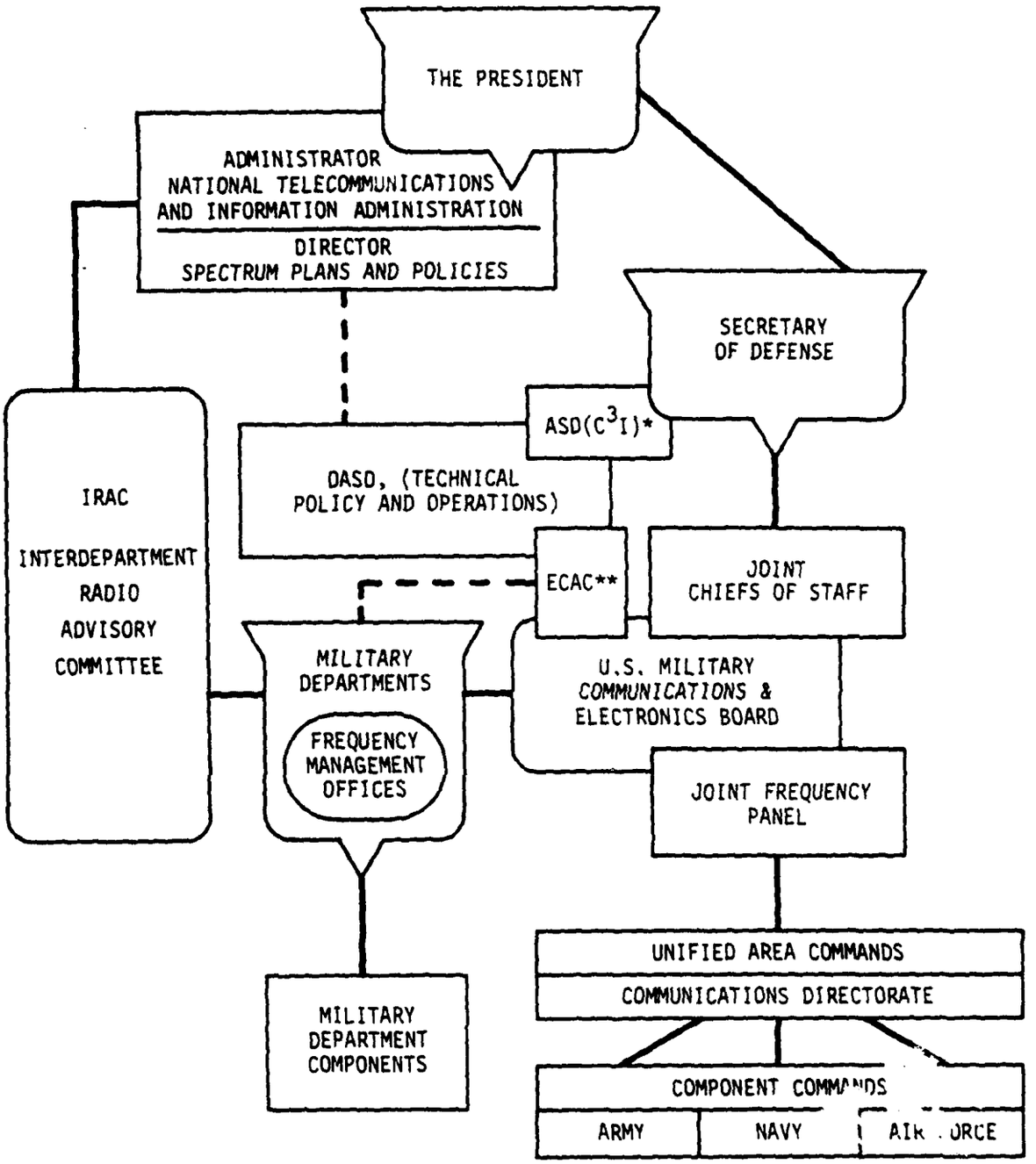


Figure B.3-6. Air Force Frequency-Management Structure



*ASD(C^3I) - ASSISTANT SECRETARY OF DEFENSE FOR COMMAND, CONTROL AND COMMUNICATIONS INTELLIGENCE

**ECAC - ELECTROMAGNETIC COMPATIBILITY ANALYSIS COMMITTEE

Figure B.3-7. DoD Frequency-Management Structure

B.3.1.4 Technical Standards. Technical standards prepared by NTIA and military standards issued by DoD are described in Subsections B.3.1.4.1 and B.3.1.4.1.2.

B.3.1.4.1 NTIA Standards. Standards prepared by NTIA are contained in the NTIA Manual, Chapter 5, Technical Standards Requirements and Objectives. These standards define minimum performance requirements (MPR) and design objectives applicable to equipment used by government radio stations.

Standards relating to frequency management fall into two major groups:

1. Standards associated with the potential impact of any system or equipment on normal operation of other systems or equipments (such as transmitter and antenna operating parameters).

2. Standards associated with provision of interference immunity for equipment and systems from normal operation of other equipments or systems (such as receiver performance papameters).

If appropriate technical data are not found in the NTIA Manual provisions of the ITU Radio Regulations normally apply. Otherwise, data contained in current recommendations of the CCIR are used as a guideline.

The MPR given in Chapter 5 of the NTIA Manual may be applicable to the DCS III study and pertinent data on bandwidth calculations are reproduced in Table B.3-1 and antenna-pattern limitations are shown in Table B.3-2. Power and modulation limitations are shown as applicable.

B.3.1.4.2 Military Standards. Military standards issued by DoD provide technical design standards for military communication systems, and include system-performance objectives for end-to-end circuit quality and availability and equipment performance parameters.

Although DCA publishes circulars containing standards for the Defense Communications System and for the National Military Command System (NMCS), standards for all military communications are recorded in the MIL-STD-188 series of documents. Military Communications System Technical Standards are divided into the three groups consisting of Common Standards (MIL-STD-188-100 series); Tactical Standards IL-STD-188-200 series); and Long-Haul Standards (MIL-STD-188-300 series). Supplement II lists of the published MIL-STD-188 series.

Table B.3-1. Bandwidth Calculations

Description and Class of Emission	Necessary Bandwidth (Hz)	Examples	
		Details	Designation of Emission
Television (visual and aural) A5 and F3	Refer to relevant CCIR documents for the bandwidths of the commonly used television systems	Number of lines: 525 Number of lines per second: 15,750 Video bandwidth: 4.2 MHz Total visual bandwidth: 5.75 MHz FM aural bandwidth including guard bands: 250,000 Hz Total bandwidth: 6 MHz	5750A 5C 250F3
Composite Transmission, A9	B_n = 2M (double sideband)	Television relay, video limited to 4-MHz FM audio on 6.5 MHz subcarrier, subcarrier deviation: 50 kHz M = subcarrier frequency plus its maximum deviation = 6.55×10^6 Bandwidth: 13.1×10^6 Hz	13,100A9
Composite Transmission, A9	B_n = 2M (double sideband)	Microwave relay system providing 10 telephone channels occupying baseband between 4 and 164 kHz M = 164,000 Bandwidth: 328,000 Hz	328A9
Composite Transmisssion, A9Y, Digital Modulation Using DSB-AM	$B_n = 2RK/\log_2 S$	Microwave radio relay specifications: digital modulation used to send 5 megabits per second by use of amplitude modulation of the main carrier with 4 signaling states R = 5×10^6 bps K = 1 S = 4 B_n = 5 MHz	5000A9Y

Table B.3-1. Bandwidth Calculations (Continued)

Description and Class of Emission	Necessary Bandwidth (Hz)	Examples	
		Details	Designation of Emission
Composite Transmission: F9	B_n = 2p + 2DK/K = 1	Microwave radio relay specifications: 60 telephone channels occupying baseband between 60 and 300 kHz; rms per-channel deviation 200 kHz; continuity pilot at 331 kHz produces 100 kHz rms deviation of main carrier. Computation of B_n: D = (200 x 10^3 x 3.76 x 2.02) Hz = 1.52 x 10^6 Hz; P = 0.331 x 10^6 Bandwidth: 3.702 x 10^6 Hz	3700F9
Composite Transmission, F9	B_n = 2M + 2DK/K = 1	Microwave radio relay specifications: 960 telephone channels occupying baseband between 60 and 4028 kHz; rms per-channel deviation 200 kHz; continuity pilot at 4715 kHz produces 140 kHz rms deviation of main carrier. Computation of B_n: D = (200 x 10^3 x 3.76 x 5.5) Hz = 4.13 x 10^6Hz; M = 4.028 x 10^6 Hz; P = 4.715 x 10^6 Hz; (2M + 2DK) > 2P. Bandwidth: 16.32 x 10^6 Hz.	16,300F9
Composite Transmission, F9	B_n = 2P	Microwave radio relay specifications: 600 telephone channels occupying baseband between 60 and 2540 kHz; rms per-channel deviation 200 kHz; continuity pilot at 8500 kHz produces 140 kHz rms deviation of main carrier.	17,000F9

Table B.3-1. Bandwidth Calculations (Continued)

Description and Class of Emission	Necessary Bandwidth(Hz)	Examples	
		Details	Designation of Emission
		Computation of B_n: $D = (200 \times 10^3 \times 3.76 \times 4.36)$ Hz $= 3.28 \times 10^6$ Hz; $M = 2.54 \times 10^6$ Hz; $K = 1$; $P = 8.5 \times 10^6$ Hz; $(2M + 2DK) < 2P$. Bandwidth: 17×10^6 Hz	
Composite Transmission, F9	$B_n = 2M + 2DK/K = 1$	TV microwave relay specifications: Aural program on 7.5 MHz, aural subcarrier deviation ±150 kHz; continuity pilot at 8.5 MHz produces 140 kHz rms deviation of main carrier; $D = 3.7 \times 10^6$ Hz (visual) plus 0.3×10^6 Hz (aural) Computation of B_n: $M = (7.5 + 0.15) \times 10^6$ Hz; $P = 8.5 \times 10^6$ Hz; $D = (3.7 + 0.3) \times 10^6$ Hz; $(2M + 2DK) > 2P$. Bandwidth: 23.3×10^6 Hz	23,300F9
Composite Transmission, F9	$B_n = 2P$	TV microwave relay system specifications: Aural program on 6.9 MHz subcarrier; aural subcarrier deviation ±150 kHz; continuity pilot at 8.5 MHz produces 50 kHz rms deviation of main carrier; $D = 2 \times 10^6$ Hz; (visual) plus 0.2×10^6 Hz (aural).	17,000F9

Table B.3-1. Bandwidth Calculations (Continued)

Description and Class of Emission	Necessary Bandwidth (Hz)	Examples	
		Details	Designation of Emission
		Computation of B_n: $D = (2.0 + 0.2) \times 10^6$ Hz; $M = 6.15 \times 10^6$ Hz; $K = 1$; $P = 8.5 \times 10^6$ Hz; $(2M + 2DK) > 2P$. Bandwidth: 17×10^6 Hz.	
Composite Transmission, F9	$B_n = 2M + 2DK/K = 1$	Sterophonic FM broadcasting (U.S. system) with multiplexed subsidary communications subcarrier, M = 75,000, D = 75,000 Bandwidth: 300,000 Hz	300F9
Composite Transmission, F9Y, Digital Modulation Using PSK	$B_n = 2RK/\log_2 S$	Microwave radio relay system specifications: digital modulation used to send 10 megabits per second by use of phase shift keying with 4 signaling states $R = 10 \times 10^6$ bits per second $K = 1$ $S = 4$ $B_n = 10$ MHz	10,000F9Y

Table B.3-1. Bandwidth Calculations (Concluded)

Description and Class of Emission	Necessary Bandwidth (Hz)	Examples	
		Details	Designation of Emission
Composite Transmission, F9Y Digital Modulation Using FSK	$B_n = R/\log_2 S + 2DK$	Microwave radio relay system specifications: digital modulation used to send 10 megabits per second by use of frequency shift keying with 4 signaling states and 2 MHz peak deviation of the main carrier. $R = 10 \times 10^6$ bps $D = 2$ MHz $K = 1$ $S = 4$ $B_n = 9$ MHz	9000F9Y
Composite Transmission, P9	$B_n = 2K/t$ $K = 1.6$	Microwave relay, pulse-position modulated by 36 channel baseband; pulse width at half amplitude = 0.4 microsecond. Bandwidth: 8×10^6 Hz	8000P9

Table B.3-2. Antenna Pattern Limitations

Frequency Band	Maximum Beam-Width (3 dB Point)	Minimum Suppression at Angle in Degrees from Center Line of Main Beam (dB)						
		5-10°	10-15°	15-20°	20-30°	30-100°	100-140°	140-180°
1710-1850 MHz	10°	-	14	16	18	23	24	30
2200-2400 MHz	8.5°	4	12	16	16	24	25	30
4.4-4.99 GHz	4°	13	20	23	24	29	31	31
7.125-8.5 GHz	2.5°	19	23	28	30	34	35	43
14.4-15.35 GHz	1.5°	21	26	31	35	37	41	48

Standards dealing particularly with transmission-media capabilities and with end-to-end system performance objectives are MIL-STD-188-100 and MIL-STD-188-322, although items concernedwith reference circuits, noise, and Bit Error Rate (BER) budgeting are still under consideration and may eventually modified. (Refer to Defense Communications Engineering Center (DCEC) Technical Report TR-12-76, for further information).

B.3.1.5 Frequency Allocation. Frequency allocation and subsequent restrictions on each frequency band constitute the heart of the regulatory barrier. The basic frequency-allocation plan is produced by the ITU-sponsored World Administrative Radio Conference (WARC). Because this frequency plan is part of the Radio Regulation (RR), each member country of the ITU therefore must comply with the ITU Frequency Plan in preparing its national frequency plan. The national plan for the United States is contained in the NTIA Manual, Chapter 4, Allotments and Plans. However, due to the fact that WARC (Geneva, 1979) has introduced changes in the ITU frequency plan, the U.S. National Frequency Plan could be changed in the future.

B.3.1.5.1 Frequency Allocation Plan Below 30 MHz. An important characteristic of stations operating at frequencies below 30 MHz (HF bands) is that the interference range of such a station will vary with the hour of day, the season, and the year. Effective interference may even exceed the boundary of the national border. If this occurs the frequencies must be registered with the International Frequency Registration Board (IFRB). Up to about 30 MHz the HF band is very congested, and operation is feasible only through random time-sharing. Nevertheless, a certain amount of interference must be accepted.

Selection of RF channels is usually accomplished by sweeping the band of interest during long periods, of search to identify RF channels having less interference. Although no country can claim absolute rights over any RF channels, by registration priority and effective permanent use of the frequencies various national agencies may exert control over a bank of RF channels or frequencies.

With only a few exceptions, the U.S. Frequency Allocation Plan for frequencies below 30 MHz does not allow all all sub-bands to be devoted exclusively to either Government and non-Government stations, but rather allocates sub-bands by type of service according to the RR. Frequency Plan for Region 2, which includes the United States and its territories. The U.S. Frequency Allocation Plan authorizes the territories.

The U.S. Frequency Allocation Plan authorized the following types of services in the HF band:

- Radionavigation
- Fixed
- Maritime Mobile
- Standard Frequency
- Radio Location
- Aeronautical Radionavigation
- Aeronatucial Mobile
- Maritime Radionavigation.

In allocating sub-bands for the various authorized service types, the U.S. Frequency Allocation Plan takes into account the peculiarities of HF propagation that require selection of the optimum operating frequency for accommodating variable ionospheric conditions in each particular case. It should be noted that for coastal operations the frequency plan identifies bands allocated to Maritime Mobile services.

Importance of HF bands in the DCS III Study arises from the fact that beyond the range of the tropospheric (600 mi) and the ionospheric (1400 mi) propagation modes only HF links can establish direct communication between two stations without intermediate relays (terrestrial or space). Through proper selection of frequencies and operational rules almost instantaneous communications between two stations can exist because the circuit is not dependent upon intermediate relays. The NITA Manual states that HF assignments are justified "when there is transmission of vital emergency, operational command, and alerting traffic of such importance as to affect the immediate survival and defense of the Nation."

In connection with military communications for tactical and training operations under Article 38, International Telecommunication Convention, stations in the Mobile service (including portable operations) of the Air Force, Army, Coast Guard, and Navy may employ any frequency when engaged in training exercises or tactical operations. The NTIA Manual identifies specific sub-bands allocated to HF Fixed-Service-Mobile and Broadcasting bands for use in tactical and training operations, and also restrictions on power and type of emision for each sub-band, the terms "tactical" and "training" being defined as follows:

> The term "tactical" emphasizes the aspects of mobility and flexibility required by such units as components of a military force whose operations (and tactics) are directed by a responsible military commander. Organizational equipment, including all communications-electronics (C.E) equipment issued to such military units is designed specifically to meet their particular needs under combat conditions. Such C-E equipment includes that required to effect communications internal to the particular unit and its components, as well as communication to the next higher/lower echelog of command and for other specialpurpose C-E systems used for surveillance, weapons control, aeronautical and meteorological aids, etc."
>
> "The term "training applies to military operations normally in connection with training or the obtaining of proficiency in all aspects of their ultimate employment as a military force in an emergency situation. The simulation of wartime operations in day-to-day use, field and fleet exercises, and major maneuvers is an essential requirement to assure immediate operational readiness."

B.3.1.5.2 Frequency Allocation Plan Above 30 MHz. The limited interference range of stations operating on frequencies above 30 MHz offers national authorities ample margin for planning future frequency allocations. To avoid conflict between organizations managing Government and non-Government frequency use, the U.S. Frequency Plan for frequencies above 30 MHz splits the bands into blocks allocated by the FCC exclusively for Government or non-Government usage. Exceptions occur particularly in bands above 40 GHz, where propagation media parameters are not totally defined.

Supplement I is a summary of the bands above 28.89 MHz allocated to Government stations for use by Fixed, Mobile, and Satellite services that identifies pertinent restrictions on use of those bands. This summary is

suggested as a preliminary guideline. Maritime and Aeronautical Mobile stations used for radionavigation and other special services are not included. Direct reference to Chapter 4 of the NTIA Manual may be necessary for analysis of DCS III alternatives.

B.3.1.5.3 Suggested Frequency Bands for Military LOS and Scatter Systems. Frequency ranges suggested for LOS and tropospheric scatter use per MIL-STD-188-313 are given in Table B.3-3. Assignments within those ranges must be in accordance with discrete block-frequency assignments and must comply with the NTIA Frequency Allocation Plan.

Table B.3-3. Frequency Range for LOS and Tropospheric Scatter Use

Usage	Block Frequency
LOS	1700-2400 MHz 2400-2700 MHz 4400-5000 MHz 7125-8400 MHz 14.4-15.4 GHz
Tropospheric Scatter*	350-450 MHz 775-985 MHz 1700-2400 MHz 2400-2400 MHz 4400-5000 MHz

* Discrete block-frequency assignments within ranges cited.

Bandwidth assignments for Long-Haul Digital Transmission per MIL-STD-108-322 are listed in Table B.3-4.

Table B.3-4. RF Frequency and Bandwidth Assignments for Digital Long-Haul Transmission

Band	RF Frequency	Assigned Bandwidth
I	4.4 to 5.0 GHz	3, 5, 7.0, 10.5, 14 MHz
II	7.125 to 8.4 GHz	3, 5, 7.0, 10.5, 14, 20 MHz
III	14.4 to 15.4 GHz	20, 28, 40 MHz

B.3.1.5.4 Spectrum Management During a National Emergency. In times of war or national emergency, the following rules apply:

1. The United States, as proclaimed by the President, shall have available the total telecommunication resources of the nation for utilization (NTIA Manual, Part 2.3.2). At such times it shall be assumed that no restriction in frequency use may limit the alternatives during conditions of high-level stress.

2. Although not specifically stated, it must be assumed that the system alternatives for current or low-level stress conditions shall be limited to those that can be implemented within the bands allocated to government stations, preferentially those under control of the JCS and complying with applicable restrictions.

3. System alternatives should be consistent with projected data prepared for the NTIA by its two subcommittees, Spectrum Planning Subcommittee (SPC) and Technical Subcommittee (TSC).

B.3.1.6 Principles/Procedures for Assignment/Coordination

B.3.1.6.1 General Procedure for Authorizing Frequency Usage. In accordance with established policies, each Government agency establishes the extent of its radiocommunication requirements, the availability of

frequencies, and their optimal allocation. The agency then conducts necessary technical studies, selects possible frequencies, coordinates their selection with other involved agencies, and files an application with the IRAC Executive Secretary. In response the FCC IRAC representative submits data assessing the impact on non-Government services by Government operations. With computerized support, the IRAC Secretariat then screens submitted applications for accuracy, completeness, and compliance before they are processed to the Frequency Assignment Subcommittee (FAS), and another computer program arranges the FAS agenda by frequency sequence and assigns a docket number to each application. NTIA reviews Government applications for adequate justification, compliance with policy and regulations, technical appropriateness, probability of major problems, and any conflicts with IRAC non-members.

Each month the FAS/FCC considers pending items and takes policy actions. When guidance is needed or an agreement cannot be reached, the applications are referred to IRAC/FCC. Important matters such as changes in the Table of Frequency Allocations or significant Government use of non-Government frequency bands, are recommended to NTIA for consultation with FCC and other appropriate agencies. Although Government applications not made public for security reasons, the public is represented by the FCC liaison representative.

After each FAS/FCC meeting the IRAC Secretariat prepares FAS minutes and submits them to NTIA for approval. After approval, the IRAC Secretariat updates the Government Master File (GMF) which lists frequency assignments to Government radio stations. Updated lists are distributed to affected agencies on a monthly basis.

B.3.1.6.2 Frequencies Assignment Principles. General principles for frequency assignments are given in Part 8.2 of the NTIA Manual and include directives applying exclusively to Government agencies. The rules are established in coordination with FCC and with rules resulting directly from the ITU Radio Regulation. The most pertenent rules are concerned with the following criteria and constraints:

- Justification for use of a radio frequency

- Restriction on use of frequencies below 30 MHz
- Funding by for electronic equipment Government agencies
- Determination of operating priorities
- Review of frequency assignments
- Restrictions for Aeronautical Mobile and Maritime Mobile bands.

Two programs under NTIA direction, Spectrum Management (established in 1965) and Spectrum Measurements (established in 1973), survey spectrum-management activity within the Federal Government and check frequencies and operational procedures of the stations used by federal agencies by means of a mobile Radio Spectrum Measurement System (RSMS).

B.3.1.6.3 Restrictions for Satellite Systems. Earth- and space-station restrictions which may be of interest to the DCS III Study include the following:

1. Sites and frequencies for earth and terrestrial stations operating in frequency bands above 1 GHz and shared with communication services shall, if possible, be alloted in locations where surrounding terrain and existing fequency usage minimize possibility of harmful interference.

2. In the 7900-7975 MHz and 8025-8400 MHz bands, power delivered to the antennas of fixed or mobile stations shall not exceed +13 dBw and the maximum EIRP shall not exceed +55 dBw. If radiated power exceeds +35 dBw, the direction of maximum radiation should, if possible, be at least 2^{0} away from the geostationary orbit (taking into account the effect of athospheric refraction). If this is impracticable, then the maximum EIRP shall not exceed 47 dBw in any direction within 0.5^{0} of the geostationary orbit or 47 dBw to 55 dBw, on a linear scale (8 dB per degree) in any direction between 0.5^{0} and 1.5^{0} of the geostationary orbit (taking into consideration the effect of atmospheric refraction).

3. In the 7900-7975 MHz and 8025-8400 MHz bands, the EIRP of earth stations, in any direction towards the horizon, shall not exceed the following limits:

   - +40 dBw in any 4-kHz band for $\theta < 0^{0}$
   - +40 +3θ dBw in any 4-kHz band for $0^{0} < \theta < 5^{0}$

For angles θ above 5^{o}, no limit on the EIRP transmitted by earth stations must be observed. Earth-station antennas for other than Space Research shall not be employed at an elevation angle less than 3^{o} measured from the horizontal plane to the direction of maximum radiation.

Earth-station antennas for Space Research services shall not be employed at elevation angles measured from the horizontal plane to the direction of maximum radiation of less than 5^{o} for near-earth operations or less than 10^{o} for deep-space operations.

4. The Power-flux density limits at the earth surface, as specified in Table B.3-5, shall apply to space stations operating in the bands and for the services indicated.

5. Non-geostationary space stations in Fixed-Satellite service shall either cease radio emissions or reduce them to a negligible level. Associated earth stations shall not transmit to these stations if there is insufficient angular separation between the non-geostationary satellite and the geostationary satellites or if unacceptable interference to geostationary satellite systems exists.

B.3.1.7 Coordination of Frequency Usage. The agency proposing a new frequency assignment or a new radio station (transmitting or receiving) is responsible for ascertaining whether harmful interference is likely to be caused by the proposed operations or by other established operations. Following Subsections B.3.1.7.1 through B.3.1.7.10 discuss certain aspects of frequency usage/coordination.

B.3.1.7.1 Basic Coordination Arrangement Between IRAC and FCC. The following arrangement was established between the Interdepartment Radio Advisory Committee and the Federal Communications Commission:

"The Interdepartment Radio Advisory Committee will cooperate with the Federal Communications Commission in giving notice of all proposed actions which would tend to cause interference to non-Government station operation, and the Federal Communications Commission will cooperate with the Interdepartment Radio Advisory Committee in giving notice of all proposed actions which would tend to cause interference to Government station operation. Such notification will be given in time for the other agency to comment prior to final action. Final action by either agency will not, however, require approval by the other agency.

The two agencies will maintain up-to-date lists of their respective authorized transmitting frequency assignments."

Table B.3-5. Power Flux Denisty Limits at the Earth's Surface from Space Stations Sharing with the Fixed and Mobile Services

Frequency band (MHz)	*Space radiocommunication Service*	*Angle of arrival (δ) above the horizontal plane in degrees*		
		0-5°	*5-25°*	*25-90°*
1670-1690 1690-1700 1700-1710 2200-2300	Meteorological-Satellite Meteorological & Earth Exploration-Satellite (for countries mentioned in ITU No. 354A) Space Research Space Research	−154 dBW/m²/4 kHz	−154 +(δ-5)/2dBW/m²/4° kHz	−144 dBW/m²/4 kHz
7300-7750 7450-7550	Fixed-Satellite Meteorlogical-Satellite	−152 dBW/m²/4 kHz	−152 +(δ-5)/2dBW/m²/4 kHz	−142 dBW/m²/4 kHz
8025-8400 8400-8500	Earth Exploration Satellite Space Research	−150 dBW/m²/4 kHz	−150 +(δ-5)/2dBW/m²/4 kHz	−140 dBW/m²/4 kHz
21200-22000	Earth Exploration Satellite	−115 dBW/m²/1 MHz	−115 +(δ-5)/2dBW/m²/1 MHz	−105 dBW/m²/1 MHz
Power Flux Density Limits at the Earth's Surface from Space Stations Sharing with the Meteorological Aids Service				
1690-1700	Meteorological and Earth Exploration-Satellite	−133 dBW/m²/1.5 MHz for all angles of arrival		
Power Flux Density Limits from Space Stations at the Receiver Input of a Station in the Fixed Service Using Tropospheric Scatter				
1670-1700 1700-1710 2200-2300	Meteorological and Earth Exploration-Satellite Space Research Space Research	−168 dBW/4 kHz (See ITU No. 470 NGA)		
Power Flux Density Limits at the Geostationary Orbit from Space Stations using Non-Geostationary Orbits				
8025-8400	Earth Exploration-Satellite	−174 dBW/m²/4 kHz		

B.3.1.7.2 Coordination of Government Proposals to Use Non-Government and Amateur Frequency Bands. As stated in the NTIA Manual, a Government frequency assignment may be authorized in a non-Government band provided the assignment is coordinated with the FCC.

Government use of non-Government frequency bands may involve policy, economic, and technical considerations. To assure that coordination may be achieved in assignment of frequencies to Government radio stations which contemplate use of a non-Government or amateur band above 25,000 kHz or use of frequencies below 25,000 kHz which, because of probable impact upon assignments by the FCC, warrants special attention, the following procedures should be observed:

1. For new uses not specifically provided for in Chapter 7 of the NTIA Manual and not covered by existing agreements with the FCC:

   The Government agency concerned may coordinate the proposed assignment informally with the FCC. If the matter can be readily resolved and if the FCC indicates that formal policy coordination with the Commission is not required, the agency desiring the assignment will submit an application to IRAC for processing.

   Should there be a problem which cannot be resolved informally, or should the FCC indicate that formal policy coordination with the Commission is necessary, the matter will be referred to NTIA by the Government agency concerned for appropriate action.

   Upon satisfactory completion of coordination with the FCC, NTIA will inform the Government agency concerned of the results and, upon acceptance by that agency of any conditions involved, instruct IRAC to process the application.

2. For proposed assignments provided for in Chapter 7 of the NTIA Manual or for those within the scope of existing agreements with the FCC:

   The Government agency concerned will submit an application to IRAC for processing in accordance with established procedures, supplemented if appropriate by advanced informal coordination with the FCC.

3. These procedures notwithstanding, any Government agency may refer any such matters to NTIA if the agency considers it desirable to do so.

B.3.1.7.3 Coordination of Military Use of Non-Government Bands. Coordination for military use of non-Government bands either at test ranges or for tactical and training operations is established between FCC field personnel and military field personnel (see Section 7.15.3 and Part 7.17 of NTIA Manual).

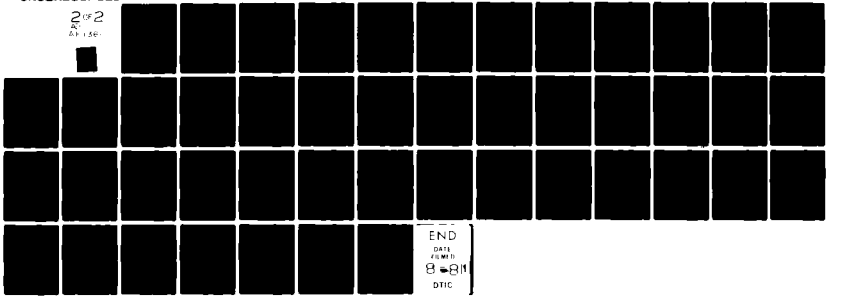
B.3.1.7.4 Intra-Military Coordination of Frequency Applications. Army, Navy, and Air Force dockets for the FAS agenda have complete military coordination concurrence by the three military services at the FAS meetings.

If, due to unforeseen circumstances, it becomes necessary for one of the military services to request tabling of the docket of another military service that appears on the regular agenda, the docket will be tabled. If no resolution is reached at the next regular FAS meeting, the docket will be withdrawn unless the applicant requests referral to IRAC.

B.3.1.7.5 Coordination of Frequency Usage Outside the United States and Possessions. To avoid harmful interference whenever possible, Government agencies will coordinate use of frequencies by their stations located outside the United States and Possessions with IRAC. Coordination of frequency by military stations is subject to requirements of military urgency and security. Coordination is ordinarily limited to operations likely to cause harmful interference to operations authorized by NTIA or the FCC. However, all U.S. Government radio operations within the Trust Territory of the Pacific Islands (except those of the U.S. Military) are coordinated with IRAC prior to activation.

B.3.1.7.6 Coordination of Assignments for Transmission or Reception by Earth Stations. Before a frequency assignment to an earth station for either transmitting or receiving is brought into use, coordination must be effected with any country whose territory lies within the coordination area of the earth station to ensure that interference will not be caused to or

AD-A101 361 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CA F/G 17/2.1
EVALUATION OF DCS III TRANSMISSION ALTERNATIVES. PHASE 1A REPOR--ETC(U)
MAY 80 T M CHU DCA100-79-C-0044
UNCLASSIFIED TRW-35142-APP-B NL



by terrestrial stations. (See No. 639AN, ITU Radio Regulations.) The coordination area is calculated in accordance with Appendix 28, ITU Radio Regulations.

Domestically, the ITU procedure for coordinating earth stations also identifies possible interference between earth stations and terrestrial stations located within the United States and Possessions.

A computer program for calculation of coordination areas, known as ITS-WARC 71.A28, is available at NTIA, Department of Commerce.

The above coordination procedure applies in the following frequency bands:

- 1427-1429 MHz
- 1588.5-1636.5 MHz
- 1670-1710 MHz
- 1750-1850 MHz
- 2025-2120 MHz
- 2200-2300 MHz
- 50000-5250 MHz
- 7145-7235 MHz
- 7300-7750 MHz
- 7900-7975 MHz
- 8025-8500 MHz
- 13.25-14.2 MHz
- 14.4-15.35 GHz
- 15.4-15.7 GHz
- 21.2-22.0 GHz

B.3.1.7.7 Coordination of Assignments for Transmissions by Terrestrial Stations. Before a frequency assignment is given to a terrestrial station which is within the coordination area of a receiving earth station of another country using the same frequency, coordination must be effected with that country to ensure interference will not be caused to the receiving earth station. (See No. 492A, ITU Radio Regulations.)

Nationally, the ITU procedure for coordinating terrestrial stations also is followed to identify possible interference to receiving earth stations located within the United States and Possessions.

The above coordination procedure applies in the following frequency bands:

- 1558.5-1636.5 MHz
- 1670-1710 MHz
- 2200-2300 MHz
- 5000-5250 MHz
- 7300-7750 MHz
- 8025-8500 MHz
- 25.4-25.7 GHz
- 21.2-22.0 GHz

B.3.1.7.8 Coordination of Assignments for Earth and Space Stations of Geostationary Satellite Systems. Before assigning a frequency to an earth or space station in a system using a geostationary orbit, coordination must be effected with other countries operating or planning such systems in the same band to ensure compatibility between different space systems. (See No. 639AJ, ITU Radio Regulations.) Coordination also is required if the proposed system would cause a 2-percent or greater increase in equivalent satellite link noise temperatures of other space systems. (See Appendix 29, ITU Radio Regulations.)

Domestically, the ITU procedure for coordinating assignments to stations in systems using a geostationary orbit also identifies possible interference to other U.S. systems using the same orbit.

A computer program for calculation of the increase in equivalent satellite-link noise temperature is available at NTIA, Department of Commerce. This program, known as ITS-WARC 71.A29, is available for use by Government agencies for computation of changes in equivalent satellite-link noise temperature.

B.3.1.7.9 Coordination in Protected Areas. Areas around the U.S. Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona, the National Radio Astronomy Observatory in Green Bank, West Virginia, and the Navy Research Station in Pendleton, West Virginia, are protected against interference. USAEPG protection covers the full band above 10 kHz, whereas in the two other cases only frequencies above 50 MHz are protected. (For limits of the protected areas, persons to be contacted, and the limit of admissible signal levels refer to Sections 8.4.8 and 8.4.9 of the NTIA Manual.) Near the Canadian Border all assignments above 30 MHz must be coordinated between the U.S. and Canada (see Part 3-4 and Section 8.4.10 of the NTIA Manual).

B.3.1.7.10 Frequencies Requiring Permanent Coordination. NTIA maintains a program for permanent coordination of the 1030-MHz and 1090-MHz frequencies used for secondary radar systems (see Section 8.4.17 of the NTIA Manual). Other frequency bands requiring permanent coordination through the facilities of the FAA and the military establishments are the following:

- 1215-1400 MHz Radiolocation
- 1435-1535 MHz Aeronautical Telemetering
- 2700-2900 MHz Aeronautical Radionavigation, Meteorological Aids
- 9000-9200 MHz Aeronautical Radionavigation

B.3.1.8 Application for and Processing of Frequency Assignments. Application for and processing of frequency assignments are discussed in Chapters 9 and 10 of the NTIA Manual. Certain important aspects are briefly presented in this subsection, details being elaborated in the Manual.

B.3.1.8.1 Application Required. Except as provided in Section 9.1.2 of the NTIA Manual, the submitter of an application for a Government radio station is required to obtain authority to use a given frequency within the United States and Possessions (see Part 7.1 of the NTIA Manual).

For satellite systems employing multiple space stations with the same general characteristics, a separate application must be submitted for each space station on a stationary satellite. For nonstationary satellites, one application is submitted covering all the space stations in the system.

B.3.1.8.2 Application not Required. An application is not required to obtain authority to use a frequency above 3,000 GHz. Parts 7.3 through 7.17 of the NTIA manual authorize use of certain frequencies under specified conditions. Submittal of an application is also not required to obtain authority for such use inasmuch as such authority is granted by the Parts cited Manual. However, if desired an application may be submitted to be recorded in the Government master file.

Mobile stations are authorized by class of station instead of individual stations (e.g., 25 mobile stations may be authorized by a single application as opposed to submitting 25 applications). In certain cases the number of authorized mobile stations is specified. An application is not required to obtain authority for individual mobile stations if the frequency is authorized to the agency for use by mobile stations as a class provided such stations do not exceed the authority granted.

No definition or station class symbol has been designated to represent a portable station. Portable operations may be authorized to defined classes of stations (e.g., fixed (FX)), by including the Record Note S016 (portable-type operations) on the application. As in the case cited previously for mobile stations, portable operations are authorized to a station class rather than to individual stations. An application is not required for individual stations using a frequency for portable-type operations provided the frequency is authorized to the agency for use by such stations as a class, that the assignment includes the Record Note S016, and that the stations do not exceed authority of the frequency assignments.

B.3.1.8.3 Application for Notification of Frequency Use. An application is used for notification of frequency use or intended use under terms of existing frequency-assignment authority, or where no frequency-assignment authority is required. Cases requiring submittal of an application for notification of frequency use are laser operations for telecommunication purposes and establishment of a station under authority of a group frequency assignment in protected areas (Sections 8.4.9 and 8.4.20 of the NTIA Manual) or in certain frequency bands (see Section 9.1.3 of the NTIA Manual).

B.3.1.8.4 Application Considered by MAG. Application for authority to use frequencies in the 225.0-328.6 and 335.4-399.9 MHz bands are handled directly by the Military Assignment Group (MAG). (See Section 9.15.2 of the NTIA Manual.)

B.3.1.8.5 Application Considered by AAG. Application for authority to use frequencies in the bands for which the Aeronautical Assignment Group (AAG) holds authority to take interim action is handled directly by the AAG (see Section 9.15.1 of the NTIA Manual). These bands include the following:

- 190-285 kHz
- 325-415 kHz
- 74.600-75.400 MHz
- 108.000-121.9625 MHz
- 123.5875-128.8125 MHz
- 132.0125-136.000 MHz
- 328.600-335.400 MHz
- 978-1020 MHz inclusive
- 1090 MHz
- 1157-1213 MHz inclusive
- 5000-5250 MHz

B.3.1.8.6 Processing the Applications. Applications for bands in which AAG or MAG hold authority to take interim action are addressed directly to those groups. All others are considered in FAS meetings. The applications are initially forwarded for screening to the Computer Support Section, where apparent or mechanical errors are corrected. However, applications with substantive errors are returned to the originating agency for correction and resubmittal.

Applications selected by the Computer Support Section are then included in the agenda of the next FAS meeting, provided the applications have reached the Computer Support Section 12 or more working days prior to the meeting (see Chapter 10 of the NTIA Manual).

B.3.1.9 Chapters of NTIA Manual. Chapters and annexes of the NTIA Manual are listed in Table B.3-6 for ready reference.

B.3.2 Regulatory Barriers for U.S. System in a Host Country

This section contains general comments on constraints and procedures to obtain authority to install and/or operate a radio or physical military communication system in a foreign country.

B.3.2.1 Barriers. U.S. Forces may install and/or operate communication networks in foreign countries under terms of a particular agreement with the host countries or under the conditions established by a regional defense treaty. Procedures to be followed to obtain authority to install, operate, and/or introduce modification in an existing network depends on the purpose of the network, and are largely different from country to country.

In very broad terms, existing arrangements may be grouped in accordance with the following sets of circumstances:

- U.S. Forces may install a communication networks without coordinating with the national regulator agencies of the host country provided they do not disturb any existing national system. Authority granted to the U.S. Forces may be broad, or restricted to specific services to be carried by the network and/or to specific technical limitations such as

Table B.3-6. National Telecommunications and Information Administration Manual of Regulations and Procedures for Federal Radio Frequency Management

Chapter/Annex	Topic
Chapter 1	Authority and Organization
Chapter 2	Telecommunication Policy
Chapter 3	International Matters
Chapter 4	Allocations, Allotments and Plans
Chapter 5	Technical Standards, Requirements and Objectives
Chapter 6	Definitions and Particular of Assignments
Chapter 7	Authorized Frequency Usage
Chapter 8	Procedures and Principles for the Assignment and Coordination of Frequencies
Chapter 9	Preparation of Applications for Frequency Assignment Action
Chapter 10	Processing of Applications for Frequency Assignment Action
Annex A	Record Notes
Annex B	Data and Procedures for Assessing Interactions Among Stations in the Space and Terrestrial Services
Annex C	Reserved
Annex D	Procedures for Field Level Selection and Coordination of the Use of Radio Frequencies
Annex E	Notification of Laser Operation for other than Telecommunication Purposes
Annex F	Five-Year Review Procedure
Annex G	Abbreviations
Annex H	Assignment Guide for Maritime Mobile Bands 4-26 MHz

specific frequency bands, etc. This type of arrangement is usually granted by the countries where U.S. Forces have bases, as in some Pacific countries and, in a certain extension, by the Germany Federal Republic.

- Authorization for installation of a communication network must be obtained through coordination with the military forces of the host country. This kind of agreement exists with countries having military treaties with the United States, and also is in effect in the case of NATO countries.

- Agreement may be reached through routine diplomatic channels and for specific purposes.

In the first of the above cases, delays from constraints due to national regulations may be largely eliminated and within the limits of authority granted to U.S. Forces, and the installation of communication networks may be directly coordinated by the U.S. Joint Chiefs of Staff (JCS) through the appropriate chain of command. In most of the other two cases, indirect or direct involvement in the process of national civil regulatory agencies should be expected.

B.3.2.2 Coordination with Military Forces of Host Countries. Although arrangements may differ from country to country, the general rule is that a commission appointed by the JCS of the host country, under the Ministry of Defense or equivalent, will coordinate with the U.S. Force Command for the region or NATO and will grant authority case by case. For radio-communications, authorization is usually restricted to pre-fixed frequencies or narrow bands.

For NATO countries other than Germany U.S. Forces are present only as part of NATO infrastructure, and coordination is accomplished through the Commission established by the host country. For radiocommunications, required operational frequencies may be applied for through ARFA the Allied Radio Frequencies Agency (ARFA) in Brussels, Belgium. The ARFA Policy Handbook (Ref. B-6) describes the application procedure.

If the communication network is to be installed and operated independently of NATO infrastructure, necessary authorization may require negotiations between governments.

Although national military forces are usually not subject to civil regulatory agencies, in cases involving authorization of an operation by a foreign country, usual procedure in all except very sensitive cases is for the national military agencies to coordinate the request with the civil regulatory agencies.

B.3.2.3 National Regulatory Agencies

B.3.2.3.1 Radiocommunication Systems. Most host countries have formed an agency responsible for radio-frequency management, issuance of license and standards for operating radio stations, monitoring radio-station operation within national borders, and assisting the government in coordination with the ITU. Outside of the United States the regulatory authority of this agency usually extends over both private and government stations, except for military forces.

Of the two common types of regulatory organizations, the first is an independent organization reporting directly to the Ministry of Communication or equivalent. This organization type is popular in South America. the second type is part of the General Telephone Authority (PTT), which itself may be an Administration reporting to the Ministry of Communication or may be at the Ministry level. This type of organization is popular in Europe, Asia, and Africa.

B.3.2.3.2 Physical Communications Systems. There are no regulatory agencies for control of physical communications systems similar to those controlling radio communications because no specific need exists. However, any country has civil laws regulating such matters as laying of cables or mounting of overhead wires.

The present worldwide tendency is for telecommunications to become either the monopoly of PTT or the monopoly of a private company operating in a concessionary basis. Because monopoly enjoyed by PTT and/or private concessionaries extends to the international circuits, establishment by the United States of a communication network by cable or other physical systems may conflict with both the PTT monopoly and the laws of the host country governing installation of cables or poles within public or private properties. Also, though the PTT or the concessionary may have established their own technical standard, that would not necessarily be applicable to a network not connected with the national system.

The PTT is inclined to consider it a break in its monopoly when another network is established by cable or by other physical means than by radio. Therefore any alternative based on cable or similar system extending outside the compounds occupied by the U.S. Forces may require lengthy negotiations.

B.3.2.3.3 Leased Private Circuits. The various types of national and international private circuits usually available for rental in the various countries fall into the three categories of telegraph, voice, and wideband circuits. Telegraph circuits are normally suitable for 50- and 110-baud telegraphy, and for low-speed data transmission of up to 110 bps. In some countries 200-baud telegraphy and 200- to 9400-bps data transmission are possible on private telegraph circuits. Voice circuits in most countries may also be used for such non-voice applications as facsimile and data transmission. Wideband circuits consist mainly of 48-kHz groups, but special quality music circuits, group band circuits (312 to 552 kHz), master group circuits (1.2 MHz) and television circuits (5.5 MHz) also are available. In underdeveloped countries wideband circuits and TV may not be available.

Charges for private circuits, although varying considerably from country to country, normally comprise an installation fee and/or a connection charge plus an annual circuits fee, but a part-time service can in some cases be arranged. Temporary services also are available under certain circumstances.

In most countries, terminal equipment for connection to private circuits either can be obtained directly from suppliers or, for certain types of circuits, rented from the PTT. However, in some cases a PTT may insist on supplying certain equipment, for example, modems. Where privately supplied equipment is allowed it must have approval from the cognizant PTT.

General principles governing provision of international private circuits are contained in CCITT Recommendations D1 to D5 (Orange Book, Volume II.1) these recommendations are applicable to international private circuits and in some cases also to national private circuits, and address the following areas:

1. Provision of leases normally of a one month minimum and thereafter by tacit agreement.

2. Allowance for refund to subscribers if a circuit is interrupted for not less than 180 minutes in the case of a continental circuit or for 60 minutes in the case of an intercontinental circuit.

3. Definition of criteria for setting up private-use networks if specified user requirements cannot be met by the public switched network or by specialized networks set up by the Administrations themselves. The equipment and circuits used and the traffic to be carried must be approved by all Administrations concerned, and cannot be significantly changed without their further approval.

4. Possible allowance of international leased circuits to access the public telex or telephone networks if this is not contrary to the law or Administration policies in the country concerned. Access to either the telex or telephone networks is subject to the conditions that the leased circuit terminates at the business premises of the customer and that calls are set up only with nominated and approved subscribers. In principle, access to the public telex network is allowed only at one end of the circuit, but Administrations may agree to allow access at both ends. Access to the telephone network is allowed at both ends of the circuit, but not simultaneously (i.e., a caller must not dial up the local end of the circuit, route through it, and then communicate from the far end to a subscriber located

remotely from the premises where the circuit terminates). Access is also normally confined to subscribers of the domestic public network of the country in which the circuit terminates, although exceptions may be made for telex calls by agreement between the Administrations concerned.

5. Allowance of the other end of a leased line terminating at one end in a computer to access public networks or other leased circuits, provided that:

   - Leased circuits connecting users with a data-processing center may not be used for direct exchange of information between different users.
   - Transmission of messages between users having access to a data-processing center is not permitted through that center.
   - The list of subscribers thus connected must be communicated to the Administrations of the countries of residence of these subscribers for their agreement.
   - Customers are not be permitted to operate in the manner of an Administration by providing a public telecommunications service.

Anticipated quality and characteristics in either national or international circuits may be appraised from CCITT Recommendations (in particular CCITT Orange Books, Volumes IV.1, VIII.1, and VIII.2 (Ref. B-2)). Some of the more important points are subsequently noted. Characteristics of circuits for telephony are summarized in Tables B.3-7 and B.3-8, as extracted from Rec. M.580, Volume IV.1.

Table B.3-7. Limits for the Overall Loss/Frequency Characteristics Between Circuits Access Points and the Access Points of Circuit Sections

(Overall loss relative to that at 800 Hz)

Frequency Hz	db Loss Between Circuit Access Points	dB Loss At the Access Point At Intermediate Stations
Circuits and circuit sections using 4 KHz spacing		
Below 300	not less than 0.0 otherwise not specified	not less than -3.0 otherwise not specified
300 to 400	+3.5 to -1.0	+9.0 to -3.0
400 to 600	+2.0 to -1.0	+6.0 to -3.0
600 to 2400	+1.0 to -1.0	+6.0 to -3.0
2400 to 3000	2.0 to -1.0	+6.0 to -3.0
3000 to 3400	+3.5 to -1.0	+9.0 to -3.0
Above 3400	not less than 0.0 otherwise not specified	not less than -3.0 otherwise not specified
Circuits and circuit sections using 3 KHz spacing		
Below 200	not less than 0.0 otherwise not specified	not less than -1.5 otherwise not specified
200 to 250	+10.5 to -0.5	not less than -1.5 otherwise unspecified
250 to 300	+6.5 to -0.5	+9.0 to -1.5
300 to 2700	+1.0 to -0.5	7.0 to -1.5
2700 to 2900	+2.5 to -0.5	+9.0 to -1.5
2900 to 3050	+6.5 to -0.5	+9.0 to -1.5
Above 3050	not less than 0.0 otherwise not specified	not less than -1.5 otherwise not specified
Circuits and circuit sections using 3 KHz and 4 KHz spacing		
Below 300	not less than 0.0 otherwise not specified	not less than -3.0 otherwise not specified
300 to 400	+3.5 to -1.0	+9.0 to -3.0
400 to 600	+2.0 to -1.0	+6.0 to -3.0
600 to 2400	+1.0 to -1.0	+6.0 to -3.0
2400 to 2700	+2.0 to -1.0	+6.0 to -3.0
2700 to 2900	+2.5 to -1.0	+9.0 to -3.0
2900 to 3050	+6.5 to -1.0	+9.0 to -3.0
Above 3050	not less than 0.0 otherwise not specified	not less than -3.0 otherwise not specified
Limits for overall loss at 800 Hz: $\pm$0.3 dB of nominal value		

Table B.3-8. Noise Objective for Public Telephone Circuit Maintenance

Distance In Kilometers	320	321 to 640	641 to 1600	1601 to 2500	2501 to 5000	5001 to 10000	10001 to 20000
Noise (dBmOp)	-55	-53	-51	-49	-46	-43	-40

NOTE: For circuits routed via satellite, the section of the circuit provided by satellite (between earth stations) will contribute approximately 10000 pWp (-50 dBmOp) to the overall circuit noise. Therefore, for the purpose of determining the maintenance noise limits for international public telephone circuits, the section of the circuit provided by the satellite may be considered, to be equivalent to a length of 2500 km. The effective noise length of such a circuit will be 2500 km plus the total length of the terminal rountings.

Transmission-stability requirements as extracted from Rec. M160, Volume IV.1, are as follows:

1. Objective for Variation of Circuit Overall Loss with Time is:

   - The difference between the mean value and the nominal value qf the overall transmission loss shall not exceed 0.5 dB for all circuits.

   - The standard deviation about the mean value of the variation of the overall transmission loss shall not exceed 1.0 dB for all circuits, although in the case of circuits which are set up wholly or in part on older type equipment and which are composed of two or more circuit sections, a standard deviation not exceeding 1.5 dB may be admitted.

2. Objective for Variation of Pilot Levels with Time on Groups, Super Groups, etc: The following values of M and S should be met, where M represents the mean deviation of the pilot level from its nominal value and S represents the standard deviation of the variations of the pilot level.

- Conditions concerning through-connection points of group, supergroup, etc. links:

  $M \leqslant 0.5$ dB, $S \leqslant 1.3$ dB

- Conditions Applicable to Receiving End:

  Group Links:

  $M \leqslant 0.3$ dB, $S \leqslant 0.6$ dB

  Supergroup Links:

  $M \leqslant 0.3$ dB, $S \leqslant 0.5$ dB

  Mastergroup Links:

  $M \leqslant 0.3$ dB, $S \leqslant 0.4$ dB

  Supermastergroup Links:

  $M \leqslant 0.3$ dB, $S \leqslant 0.3$ dB

Performance of leased circuits and of leased groups and supergroups for data transmission must be in accordance with applicable requirements (see Orange Book Vol. IV.1, Sections 5 and 6). The present tendency is to operate with synchronous data transmission. The standard data signalling rates are 600, 1200, 2400, or 4800 bps according to CCITT (see Orange Book Vol. IV.1 Rec. V5). Modems for use in the general switched telephone network at the above data signalling rates must be in accordance with applicable recommendations (see Orange Book Vol. VIII,.1, Recs. V.23, V.26, and V.27). Modems operating at 9600 bps over leased circuits must reflect required standards (see Orange Book Vol. VII.1, Rec V.29).

For wideband synchronous data it is recommended that the data should be scrambled to avoid restrictions on the data input format (see Orange Book Vol. VIII.1, Rec. V.35) for wideband modems for data transmission at 48 kbps using 60-108 kHz ground-band circuits.

B.3.3 National Regulatory Barriers of Germany

The German Federal Republic (FR) as a member of the ITU is subject to constraints imposed by the ITU Radio Frequency Table and by ITU frequency-management procedures and restrictions. Also, similarly to most other countries, Germany follows or is taking the steps to adopt CCIR and CCITT standards and recommendations for their circuits and systems. Therefore, regulatory barriers discussed in Section B.1 of this resport also apply to Germany unless otherwise indicated. The following discussion is based on information from other sources.

B.3.3.1 Regulatory Responsibility. In the German Federal Republic overall authority for telecommunications is vested in the Federal Minister for Posts and Telecommunications (Bundesminister fur das Post und Fernmeldewesen). This authority derives from the Telecommunication Equipment Law (Fermeldeanlangengestez) 1977, which also assigned administrative responsibility for telecommunications to the Duetsche Bundespost (DBP). Subsequently, the Postal Administration Law (Postverwaltungsgesetz) extended and specified with greater precision the responsibilities of the Federal Minister for Posts and Telecommunications.

The DBP holds monopoly to set and operate telecommunications installations, or it may grant a license to do so. Certain groups of users such as public authorities and transportation companies do not need a DBP license to set up and operate their own telecommunications installation, provided that certain basic requirements are met.

The of Federal Ministry for Posts and Telecommunications organization includes the following agencies:

- Central Telecommunications Office (Fernmeldetechnisches Zentralamt (FTZ))
- Central Postal Office (Posttechnisches Zentralamt (PTZ))
- Higher Postal Directorates (Oberpostdirektionen)
- Berlin Postal Directorate (Landespostdirektion Berlin)
- Bundespost Social Office (Sozialamt)

- Lower Federal Authorities (untere Bundesbehorden), comprising Administrative Post Offices (Postamter mit Verwaltungdienst), telecommunications offices (Fernmeldeamter), Telegraph Offices (Telegrafenamter), and other functional organizations.

Main overall objectives of the Central Telecommunications Office (FTZ) with Headquarters located in Darmstadt are to provide advice on development of telecommunication systems and equipment, regulatory and pricing policies, coordination of international cooperation in telecommunications, and research in communications. Despite the overall authority of the Ministry, the FTZ is in fact the executive body governing telecommunications and also is the point of contact for subscribers.

The FTZ is headed by a president supported by a permanent representative, a vice president, an internal administration department and four Departments. The Departments are responsible for preparation of short- and long-term objectives, establishing general principles, proposing solutions to fundamental questions, and coordinating comparable technical developments within the following areas of responsibility:

- Principal Department A: Cable-based telecommunication techniques (Drahtgebundene Fernmeldetechnik)
- Principal Department B: Telecommunication services, acquisition/operational matters (Fernmeldedienste, Beschaffung, Betriebswirtschaftliche Angelegenheiten)
- Principal Department C: Telecommunication networks, radio (Fernmeldenetze, Funk)
- Principal Department D: Organization and electronic data processing for telecommunications (Organization und Elektronische Datenverarbeitung im Fernmeldewesen)
- Research Institute of the German Post Office at the FTZ (Forschungsinstitut der DBP beim FTZ) (formerly known as Principal Department D): Determination of future techniques, analysis of technical development at national and international levels.

B.3.3.2 Equipment Approval. Terminal equipments may be purchased or rented from the Bundespost (DBP) or may be privately supplied and maintained. Privately supplied equipment must be approved by the DBP. The equipment approval must be granted by the FTZ in Darmstadt, but the connection to the line is also subject to agreement of the local telecommunication offices (Fernmeldeamt). The application for approval must be addressed to the FTZ, (Postfach 5000, Am Kavalleriesand 3, 6100 Darmstadt 2), written in German, and accompanied by a description (in German) of the equipment (in duplicate), a detailed diagram (in duplicate), and
a legally binding declaration that the equipment corresponds to VDE (Verband Deutscher Elektrotechniker) requirements. A sample of the equipment or of its parts must be made available to the FTZ on request.

The application must comply with specific format, and a charge is imposed for approval and testing, dependent on labor costs. Relevant FTZ documents governing equipment for equipment approval include the following:

- General regulations for approval of data equipment for connection to telecommunication networks (Allgemeine Vorschriften uber Zulassungen von Dateneinrichtungen zum Anschluss an Fernmeldewege)
- Regulations for data transmission equipment for telex connections (Vorschriften uber Einrichtungen bei Telexstellen zur Ubertragung von Daten)
- Technical requirements for connection of terminal equipment to telegraph circuits with speeds of up to 75 baud (Technische Vorschriften fur den Anschluss von Endeinrichtungen an uberlassene Telegrafenstromwege bei Schrittgeschwindigkeiten bis zu 75 baud)
- Technical requuirements for connection of terminal equipments to telegraph circuits with speeds of 75-200 baud (Technische Vorschriften fur den Anschluss von Endeinrichtungen an uberlassene Telegrafenstromwege bei Schrittgeschwindigkeiten uber 75 bis 200 baud) (as in the third item above, but for speeds of 75-200 baud)
- Technical requirements for private modems connected to leased telephone circuits (Technische Vorschriften fur private Modems an Uberlassenen Fernsprechstromwegen)

- Interface requirement for Modems (Schnittstellen-bedingungen fur posteigene Datenubertragungsgerate)
- Interface requirements for data equipment (Schnittstellenbedingungen fur posteigene Daten-fernschaltegerate im Datexnetz).

B.3.3.3 Available Public Communications Services. The five different types of public communications services now available in the German Federal Republic, which include the telephone network (PSTN), private circuits, public telegraph services, data networks, and miscellaneous services, are discussed in Subsections B.3.3.3.1 through B.3.3.3.5.

B.3.3.3.1 Public Service Telephone Network. The telephone service in the German Federal Republic is operated by the Deutsche Bundespost (DBP). Inquiries and orders are handled by the local telecommunications bureau, and the Fernmeldetechnisches Zentralamt (FTZ) in Darmstadt advises customers regarding non-routine matters or difficulties concerning data transmission over the telephone network.

The telephone network consists of four levels. The first network level is based on eight "central" exchanges located in the cities of Berlin (West), Hamburg, Hannover, Dusseldorf, Frankfurt, Stuttgart, Munich, and Nuremberg, and interconnected by cable and radio relay links connecting West Berlin with the rest of the network. With the exception of West Berlin each central exchange area comprises about 10 "main" exchange areas at the second network level which are each connected to a central exchange by means of a star-shaped network and to adjacent central exchanges via direct routes. Structure of the third network level of "nodal" exchanges is similar to that of the second level, and the fourth level consists of a purely star-shaped structure, with each included subdivision serving a local area.

In Germany, all subscriber lines are connected to automatic exchanges, and thus all inland calls can be self-dialed. Subscriber dialing is possible for calls to all countries in Western Europe, the United States, and a number of other destinations such as Japan. About 98 percent of all international calls are subscriber-dialed.

A stored program control switching system called Elektronisches Wahl System (EWS) is gradually being introduced throughout exchanges of the Federal Republic. This exchange type, in which the first local systems were introduced in 1974, is expected to be exclusively used after 1985.

Data transmission over the public telephone network is possible at speeds of up to 2400 bps. Under optimum conditions the waiting time for an exchange line is about four weeks after receipt of a firm order. In areas where a shortage of exchange lines exists, installation may take up to a few months.

B.3.3.3.2 Private Circuits. The Deutsche BundesPost (DBP) through its regional and local telecommunications offices can make circuits available for private use. Restrictions imposed on use of private circuits in Germany are very stringent, and refer mainly to requirements that leased circuits must be established only between premises held by one and the same legal person and no other satisfactory communication over the public network is available.

A detailed account of conditions which must be fulfilled before a license for a private circuit may be granted is contained in the document Private Telecommunication Installations (Private Drahtfernmeldeanlagen), which was published in the Amtsblatt des Bundesministers fur das Post und Fernmeldewesen No. 40 (Official document of the Ministry for Post and Telecommunications) on 22 March 1976.

Telephone circuits of both normal and special quality are available. Speeds up to 4800 bps usually are possible on normal quality circuits , whereas higher speeds (e.g., 9600 bps) as a rule are only possible if the lines are conditioned to special quality. Bandwidths used are normally 300-3400 Hz and in some cases 0-3400 Hz.

Telegraph circuits are available for speeds of 50, 100 and 200 bauds.

For speeds higher than 9600 bps a wide-band circuit is normally required. Wide-band circuits are available with bandwidths of 10, 48, 240 kHz and higher. Music and television circuits also are available, and circuits for private community antenna installations and coaxial cable terminals for cable television (public networks in local districts) have been offered since April 1978.

Where requirements cannot be met for obtaining a license for a private circuit the usual alternative to a leased line for data transmission is a connection to the public network for "fixed connections". A fixed connection is typically more cost-effective than a private circuit and allows communications between different subscriber organizations. In applications for license, private-circuit customers are required to provide exact details of the configuration of the circuit network (including a diagram).

The application form can be obtained from the nearest telecommunication office. It should be submitted in duplicate to obtain the license. This license is usually valid for 10 years unless withdrawn by the DBP or relinquished by the customer.

Waiting time for installation of inland private telegraph and telephone lines is usually about six weeks, and longer in some areas. International circuits normally can be installed within two months except for wide-band circuits, for which a notice period of at least six months is required.

There is no minimum rental period for telephone and telegraph circuits, but wideband circuits with a bandwidth of up to 48 kHz must be rented for a minimum of three years and wideband circuits with a bandwidth over 48 kHz for at least five years.

Access to the public network is not normally permitted. However, international circuits used for data transmission or telegraphy can have access to the German public networks provided that at the foreign end there is no access to public networks (in this case CCITT coefficient 1 applies).

The error rate to be expected on private telephone circuits is normally about 1 bit per million. Typical error rates on a telegraph circuit are in the range 2 to 20 bits per 10 million at 50 bauds, and 1 to 10 bits per 10 million at 100 and 200 bauds.

B.3.3.3.3 Public Telegraph Services. The telex service in the Federal Republic of Germany is operated by the Duetsche Bundespost (DBP). The configuration of the German telex network is similar to that of the telephone network, but with fewer network levels. According to the DBP regulations Telex-PBXs may be connected to the telex network. Public telegraph traffic (telegrams) is handled over the Gentex network.

The inland telex service is fully automatic. International service is also established with all major European countries, the United States, and other non-European countries. About 98 percent of all international traffic is subscriber-dialed. The German telex network is currently the largest in the world (116,000 subscribers).

The network allows data transmission at a speed of 50 bps. (For the transmission of data over the Datex network see Subsection B.3.3.3.4).

The new Electronic Data Switching System (Electronsches Datenvemitthlungs System) (EDS) is being introduced in the German Federal Republic. EDS will integrate the telex, Datex, and Gentex networks as well as the Public Network for 'fixed connections'. Later it will also be possible to send asynchronous transmission in the public telex network. The first EDS exchange was installed in 1973 and it is expected that within a decade it will replace the existing TW39 electro-mechanical telegraph switching System.

Normal waiting time for a telex installation is four to six weeks. For normal telex operations International Telegraph Alphabet (ITA) No. 2 must be used. If the telex network is used for transmission of data, alphabets other than the ITA No. 2 may be used.

A range of special services is available at extra monthly rentals, such as special connections for simultaneous transmission to up to 30 other subscribers, short dialing, and direct call. These services are related to introduction of EDS.

The error rate to be expected in the telex network is approximately 1 to 10 faulty bits per 10 million bits sent.

The DBP does not supply teleprinters, as these must be provided by the subscriber and are subject to previous approval. Equipment supplied by Siemens and Standard Electrik Lorenz is approved.

It is possible to connect data-processing equipment directly to the telex network provided DBP requirements are met. All equipment to be connected to the telex network must previously be approved by the DBP.

Ordinarily the DBP only maintains its own installation and equipment. However, if subscriber equipment is made up of pieces of common telecommunications technology, the DBP normally will maintain the teleprinter and most associated equipment for a monthly charge. A special maintenance service during the night and at weekends for telex main stations was introduced in April 1978.

B.3.3.3.4 Data Networks. Datex, a circuit switched data network that was inaugurated in 1967 for operation at a speed of 200 bps, now is allowing signalling rates of up to 9600 bps. Together with public networks and telex it currently is being integrated into the EDS network.

Datex is available in 200, 2400, 4800, and 9600 bps. A number of special services will be introduced for Datex subscribers at additional charge as the appropriate EDS supporting facilities, including closed user groups, permanent connections, short-dialing, direct call, multi-address, advice of charges, and identification of the called subscriber become available.

B.3.3.3.5 Miscellaneous Services

The following miscelleanous services are available now or will be available in the near future:

- Public Service Telephone Network (PSTN) Services:

- Mobile Car Radio Telephone Service (nationwide, partly automatic since 1972, fully automatic since 1 January 1978; 9800 subscribers)

- Radio Paging Service (call numbers to DBP centers differing from those for subscribers to both DBP and foreign centers of CEPT countries; 5300 subscribers)

- River Rhine Radio Telephone Service (3300 shipboard stations)

- Maritime Mobile Radio Services (including radio services for safety of life at sea)

- Emergency Telephone Services

- Conference Telephone Service (since 1976).

• Separate Networks and Services:

- Public Photograph Service (subscriber and public photograph stations; inland connections and connections to 58 countries all over the world are possible)

- Public (local) Cable Television Service

- Absent-Subscriber Service, Alarm Call Service, Information Service, and others

- Radio Broadcasting Services (for sound and television broadcasting)

- Radio communications for Multiple Destinations.

• Services Intended or on Trial:

- Public Facsimile Service on PSTN

- Public Packet Switched Data Service

- Public Teletext Service (2400 bps)

- Public Viewdata Service (telephone with TV)

- Public Videotext Service (TV boradcast)

- Public Electronic Information Service.

B.3.3.4 Implication of German FR Regulatory Barriers. In accordance with terms of the Status of Armed Forces Agreement, U.S. Forces stationed in the German FR have authority to establish communication networks in specific bands, in particular in the 7.25-8.4 GHz band. As part of NATO, U.S. Forces also may obtain authority through ARFA to establish a communication network if that network can be considered as a NATO infrastructure. Otherwise, any authorization for installing and/or operating a network must comply with rules and regulations of the Bundespost and the FTZ.

Various sources agree that the Bundespost/FTZ is a difficult barrier for establishment of a communication network in Germany unless that network is established through facilities rented from the Bundespost and also uses German equipment.

Although official contact between U.S. Forces and the German government is through German Forces, the Bundespost ordinarily becomes involved and has the last word. It can be speculated that a radio system with equipment installed inside of existing U.S. Military compounds may enjoy increased chances of being authorized by the Bundespost than a physical system requiring installation outside of U.S. compounds, the Bundespost has been reducing the number of RF channnels that could be used. Balloons or RPV solutions therefore would probably encounter difficulty due to extended interference range.

B.3.4 National Regulatory Barriers of Turkey

B.3.4.1 Regulatory Responsiblity. Unlike Germany, Turkey has not developed a well-established system for frequency management and for implementation of other regulatory responsibilities. Frequency assignment is under control of the Turkish General Staff (TGS), the General Directorate of PTT is responsible for regulating civil use of telecommunication, and Turkish radio-frequency management is in accordance with ITU Radio Regulations.

B.3.4.2 Standards. Turkey follows CCIR and CCITT Recommendations, although implementation of those standards is progressing slowly. For data transmission the PTT adopts CCITT Recommendation 1020.

B.3.4.3 Available Service. Data and voice-channel lines may be leased from the PTT. A telephone line may carry up to 9600 bps, and high-speed data transmission up to 48 kbps may be transmitted in the 60-108 kHz FDM band. The PTT administrations usually do not supply data transmission facilities and the customer must supply terminal equipment. The telegraph network is country-wide, interconnecting the main Turkish cities. The telegraph network is being replaced by a telex network, but available lines do not meet the demand. A limited number of facsimile transmission networks exist between the largest cities. The Turkish Radio and Television Organization uses radio links owned and maintained by the PTT.

B.3.4.4 Implication of Turkish Regulatory Barriers. No particular constraints are expected from the Turkish Regulatory Barriers per se for installation and operation of a U. S. military communications system, provided an agreement supported by the TGS has been reached by the U.S. Government. Thus, significant constraints are associated with the political relationship between the United States and Turkey. Although Turkey is a member of NATO, coordination through NATO is not always smooth.

Considering the current structure of the Turkish national telecommunications system, any U.S. military communications network cannot rely heavily on services made available by the PTT.

B.4 COMPARISON OF MIL-STD-188 SERIES WITH CCIR RECOMMENDATIONS

Most ITU member countries have adopted or in the process of adopting the CCIR and CCITT recommendations as national standards. These numerous recommendations have been detailed in Sections B.1.2.2 and B.1.3.2, U.S. military standards have been addressed in Section B.3.1.4, and Supplement II lists U.S. Military Standards (MIL-STD-188).

It also is of interest as well as useful for DCS III system design pruposes to examine compatibility of these ITU recommendations and U.S. Military Standards, although it is very obvious that detailed and exhaustive comparison of MIL-STD-188 series with ITU recommendations is not possible due to limited resources and time allocated for DCS III study. Comparisons of noise objectives for LOS analog systems and of bit error rate (BER) objectives for LOS digital systems that have been made are elaborated in following Sections B.4.1 and B.4.2.

B.4.1 Noise Objective Comparison for LOS Analog Systems. This section indicates how much a DCS 22,224-km (12,000 nmi) reference circuit would be degraded if a civil system designed in accordance with CCIR noise objectives replaced the full length of the MIL-STD-188-313 LOS radio transmission subsystem. This comparison is restricted to the thermal noise contribution from the radio path and reflects the assumption that for both military and CCIR designs the noise contribution of the equipment is identical.

B.4.1.1 Noise Allocation for Military LOS Subsystem. MIL-STD-188-313 Sections 4.1.2.1.1.1 and 4.1.2.1.1.2, states the following premises:

- The total long-term median noise from all sources in any nominal 4-kHz channel shall not exceed 1110 pWp0 over a 333-nmi reference circuit.
- For design noise calculations, the long-term median noise constitutes the noise constitutes the noise existing when all hops of the real section are faded 3 dB below the level corresponding to the calculated median transmission-loss value.

- For field-test purposes, median noise is defined as the noise measured with all hops of the real section in an unfaded condition plus the calculated additional thermal (front end) noise if each hop in the real section were faded 3 db below the calculated median transmission-loss value.

- Short-term mean noise power with an integration time of 5 msec and occurring on any referenced 4-kHz channel, shall not exceed 316,000 pWp0 for more than an accumulated 2 minutes during any month or for more than 1 minute during any hour over any hop in a real section. Short-term noise caused by propagation characteristics is determined from measured or statistical data appropriate to the geographical region.

The subsystem consists of 12 hops. For that subsystem if N_e is the total noise contribution of the equipment and N_t is the total receiver front-end thermal noise for unfaded conditions, from the foregoing premises the noise objective for unfaded conditions would be:

$$2 N_t + N_e = 1110 \text{ pWp0} \quad (1)$$

For LOS systems designed in accordance with CCIR Recommendation 395-2, the noise objective is that psophometrically-weighed noise power at a point of zero relative level in any telephone circuit should not exceed 3L pWp0 for more than 20 percent of any month and 47,500 pWp0 1-minute mean power for more than (L/2500) x 0.1 percent of any month.

Because the military LOS subsystem consists of 12 hops averaging 50 km per hop, then for the purposes of CCIR, L = 600 km and accordingly,

$$3L = 1800 \text{ pWp0} \quad (2)$$

and

$$\frac{L}{2500} \times 0.1 = 0.026 \text{ percent} \quad (3)$$

Comparison of CCIR Recommendation 395-2 versus MIL-STD-188-313 requirements then demands consideration of the long-term mean-noise objective and short-term noise performance.

B.4.1.1.1 Long-Term Mean-Noise Objective. The unfaded noise objective per MIL-STD-188-313 as given by (1) and the CCIR objective as given by (2) is that the mean noise is not exceeded during more than 20 percent of any month. There is no consistent way to relate this objective with the unfaded noise. However, most designers assume the unfaded noise to be 3 dB below 3L as given by (2). Accordingly, using N_t = total thermal front-end noise on unfaded conditions and the equipment noise N_e, the unfaded noise objective is

$$2N_1^t + N_e = 1800 \text{ pWp0} \tag{4}$$

From (1) and (4), then

$$N_1^t - N_t = 345 \text{ pWp0}$$

which indicates that the CCIR long-term mean nooise for the subsystem would be 345 PwpO higher than that specified by MIL-STD.

B.4..1.1.2 Short-Term Noise Performance. In regulating short-term noise, MIL-STD-188-313 requires that 316,000 pWp0 should not be exceeded by more than an accumulated 2 minutes during one month, which means that the probability of 316,000 pWp0 being exceeded must be

$$P < \frac{120}{31 \times 24 \times 3600} = 4.5 \times 10^{-5}$$

Authorities have noted that when fading is due to multipath, there is a linear relation between the ratio of the fading margin and probability P that the signal level will drop more than the fading margin. Thus letting M be the fading margin defined by the ratio of the unfaded power at receiver input to the fading signal power at receiver input cooresponding to a 316,000 pWp0 in the voice channel, and inserting C as a constant for a particular path, month, and diversity arrangement, it is found that

$$P = \frac{C}{M}$$

or

$$M = \frac{C}{P}$$

If the noise exceeds 316,000 pWp0 with a probability P 4.5×10^{-5}, then the fading margin M_m per loop must be:

$$M_m = \frac{C}{4.5 \times 10^{-5}} = 2.2 \times 10^4 C \quad (5)$$

CCIR specifies that 47,500 pWp0 shall not be exceeded by more than P^1 = 0.026 percent = 2.6×10^{-4} for any month. Accordingly, if M^1 is the ratio of the unfaded received signal power to the signal power corresponding to 47,500 pWp0 noise, then

$$M^1 = \frac{C}{2.6 \times 10^{-4}} = 3.8 \times 10^3 C \quad (6)$$

Because 316,000 pWp0 is usually lower than the noise corresponding to the FM improvement threshold and if the link is designed in accordance with (5), the fading margin associated with 316,000 pWp0 would be

$$M_c = M^1 \times \frac{316,000}{47,500} = 2.5 \times 10^4$$

The latter calculation therefore indicates that a link designed per CCIR standards has a fading margin which is 10 log $2.5 \times 10^4 / 2.2 \times 10^4$ = 0.5 dB better than the margin required by MIL STD-188 313.

B.4.1.2 Conclusion. Assuming the conditions of the model, the replacement of a MIL-STD-188-313 LOS Subsystem with a civil system designed per CCIR standards would result in the following:

- An increase in long-term median noise by 345 pWp0 over the subsystem, or 345/12 = 28.7 pWp0 per hop.

- A slight improvement in short-term noise performance.

B.4.2 BER for LOS Digital Systems

This section examines performance of the DCS 22, 224-km reference circuit, which may include a 617-km (333-nmi) digital LOS subsystem. The reference link of that LOS subsystem would be a 50 -km (27-nmi) link for operation below 10 GHz or a 25-km (13.5-nmi) link for operation above 10 GHz.

B.4.2.1 Comparison of MIL-STD-322 and CCIR Recommendation 557

Performance parameters per MIL-STD-188-322 for LOS digitial microwave transmission are indicated in Table B.4-1.

Table B.4-1. Performance Parameters for Los Digital Microwave Transmission

Parameter	600-km Reference Subsystem	*Reference Link
Bit Error Rate		
a. below 10 GHz	60×10^{-9}	5×10^{-9}
b. above 10 GHz	48×10^{-9}	2×10^{-9}
Availability		
a. BER = 5×10^{-9} below 10 GHz	0.9994	0.99995
b. BER = 1×10^{-2} below 10 GHz	0.9997	0.99998
c. BER = 2×10^{-9} above 10 GHz	0.9992	0.99997
d. BER = 1×10^{-2} above 10 GHz	0.9995	0.99998
Bit Count Integrity	TBD	TBD

Notes:

1. Reference Link = one full duplex radio path with one radio at each end.
2. Travel time to site for repair is not included in availability calculation.
3. TBD = To be determined.

CCIR Recommendation 557 establishes that for a hypothetical 2500-km reference digital radio relay system the availability objective should be 99.7 percent (computed over a statistically valid period). However because Recommendation 557 does not apply to real circuits, it is not quoted in specifications for real systems, for acceptance tests, or in operational agreements.

Recommendation 557 includes the following pertinent concepts:

- The concept of unavailability of a hypothetical reference digital path should reflect awareness that in at least one direction of transmission one or both of the two following conditions occur for at least 10 consecutive seconds:
  - The digital signal is interrupted (i.e., alignment or timing are lost).
  - The error rate is greater than 10^{-3}
- The estimate of unavailability must include all causes which are statistically predictable, unintentional, and resulting from the radio equipment, power supplies, propagation, interference, auxiliary equipment, and human activity. The estimate of unavailability also considers the mean time to restore (unavailability of multiplex equipment is not included).
- The value of 99.7 percent is a provisional one and assumes recognition that in practice selected objectives may fall into the range 99.5 to 99.9 percent. Choice of a specific value within this range depends upon optimum allocation of outage time among the various causes which may differ when local conditions are taken into account (i.e., propagation, geographical size, population distribution, organization of maintenance). Also, the availability factor of radio-relay systems is only one of many calculations to ensure an acceptable grade of telephony traffic service. Choice of an optimum value for this particular aspect can only be made by considering all existing or planned transmission systems in the network under study. For these reasons Administrations may select different values of availability objective for use, with such values lying in the above-noted range.

Assuming the CCIR unavailability finding of 0.03 (1-0.997) decreases in proportion to the ratio of the length of the reference link to the 2500-km link of the reference system, the unavailability factors become the following:

- Below 10 GHz (L = 50 km) — Unavailability = 0.0006, Availability = 0.99994
- Above 10 GHz (L = 25.5 km) — Unavailability = 0.0003, Availability = 0.9997

The foregoing availabilities apply to a BER = 10^{-3} and are smaller than those given in Table B.4-1, which refer to a different (smaller) BER. Accordingly, there is no direct way of relating the MIL-STD and CCIR objectives.

B.4.2.2 Conclusion. Because CCIR Recommendation 557 is not used for design, there is no recommended standard approach for designing an LOS digital microwave system. Existing systems were designed in accordance with technical criteria gathered by the responsible national agencies. Use of existing LOS digital links as part of the DCS 22,214-km circuit therefore must be ultimately checked case by case.

It should be noted that MIL-STD-188-322 is assumed to be in a preliminary state and will probably be replaced. A design objective based on a more realistic concept of availability has been tentatively advanced in DCEC TR-12-76 and may soon supersede those performance parameters established by MIL-STD-188-322.

If the DCS III Study indicates an advantage in using national public networks, active participation by DoD in CCIR groups working on Question 12 - 3/9, Digital Radio Relay Systems, should occur so that recommendations being prepared will be consistent with the MIL-STD used by DCS.

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SUPPLEMENT I

SUMMARY OF BANDS ABOVE 28 MHZ TO BE USED BY
FEDERAL GOVERNMENT STATIONS FOR FIXED,
MOBILE, FIXED-SATELLITE, AND MOBILE-SATELLITE SERVICES

Band (MHz)	Allocation	Restrictions and Remarks
28.89-29.9	Fixed	In the exclusive Government bands between 29.89 and 50 MHz, stations with authorized bandwidth equal to or less than 16 KHz shall follow pre-established channeling. This channeling must be used for all stations after July 1, 1983.
	Mobile	
30.0-30.56		
32.0-33.0		
34.0-35.0		
36.0-37.0		
38.0-39.0		
40.0-42.0		
46.6-47.0		
49.6-50.0		
138.0-144.0	Fixed	The fixed and mobile services are limited primarily to operations by military services. Frequencies of 143.90 and 148.15 MHz may be authorized to Air Patrol land stations and Civil Air Patrol Mobile stations and Civil Air Patrol Mobile stations. Frequencies of 150.775 and 150.790 MHz are authorized for Government/non-Government operations in medical radio communications systems.
	Mobile	
	Space-Research (space-to-earth)	
148.0-149.9	Fixed	
	Mobile	
150.05-150.8	Fixed	
	Mobile	
162.0125-173.2	Fixed	Allocated on a primary basis to non-military agencies.
	Mobile	
173.4-174.0	Fixed	
	Mobile	
225.0-328.6	Fixed	243 MHz is the frequency used by Government/non-Government survival-craft stations and equipment used for survival purposed. Fixed and Mobile services are limited primarily to operation by military services. Mobile-Satellite service in 240.0-328.6 MHz and 335.4-399.9 MHz bands is limited to military systems.
	Mobile	
335.4-399.9	Fixed	
	Mobile	

Band (MHz)	Allocation	Restrictions and Remarks
406.0-406.1	Mobile-Satellite (earth-to-space)	Shared with non-Government.
406.1-410.0	Fixed Mobile Radio Astronomy	406.125 MHz may be allocated on secondary basis for non-Government stations to transmit hydrological and meteorological data. All new authorization in the 406.1-410 band will be limited to a maximum of 7 watts for KHz of authorized bandwidth and will require coordination with the Committee of Radio Frequencies of the National Academy of Sciences.
410.0-420.0	Fixed Mobile	Allocated on primary basis to non-military agencies.
1350-1400	Radio Location (Fixed and Mobile on secondary basis)	Radiolocation and Fixed Mobile services are limited to military services. Radio astronomy observations on the doppler-shifted hydrogen line of the 1350-1400 MHz band are carried out on unprotected basis by some authorized observatories. The frequency of 1381.05 MHz with emissions limited to ±12 MHz is also allocated to Fixed and Mobile-Satellite services (space-to-earth) for relay of nuclear-burst data.
1427-1429	Fixed Mobile Space Operation Telecommand	Shared with non-Government space operation. Fixed and Mobile services are limited primarily to operations of military services. Applicants Applicants in the 1427-1429 MHz band are urged to take all necessary steps to avoid interference in the adjacent radio astronomy bands.
1420-1435	Fixed Mobile	

Band (MHz)	Allocation	Recommendations and Remarks
1710-1850	Fixed Mobile	Space command control, range and range rate system for earth station transmission only (including installation in certain Navy ships) may be accommodated on a co-equal basis with fixed and mobile services in the band 1761-1842 MHz; coordination case by case is required.
2200-2290	Fixed Mobile Space Research, Space-to-Earth	Fixed, LOS only, and Mobile, LOS only, including aeronautical telemetering but excluding flight testing of manned aircraft. Telemetering, tracking, ranging, analog/digital data, and/or voice from operation at space station may be accommodated on a co-equal basis with fixed mobile services and space research.
4400-4990	Fixed Mobile	Government and non-Government observations of the formal dehyde line frequencies 4825-4835 MHz band may be made at certain observatories.
7125-7250	Fixed Mobile	No assignments except those in accordance with Government Table of Frequency Allocations.
7250-7300	Fixed-Satellite (space-to-earth)	
7300-7450	Fixed Fixed-Satellite (space-to-earth) Mobile	Military earth stations in the 7250-7750 and 7900-8400 MHz bands may be fixed, transportable, or loacated on board a ship or aircraft.

Band (MHz)	Allocation	Recommendations and Remarks
7450-7550	Fixed Fixed-Satellite (space-to-earth) Mobile	In the 8025-8400 MHz band, Earth Resources Satellite (ERS) System earth stations (receiving) within the US&P will be limiteding in number. It may be necessary to operate Fixed-Satellite service earth stations (transmitting) within the coordination area of an ERS earth station. Such operations will be coordinated in accordance with established procedures. In the 8175-8215 MHz bands, it may be necessary to operate meteorological-satellite earth stations (transmitting) within the coordination area of an Earth Resources Satellite (ERSO) earth station (receiving). Such operations will be coordinated in accordance with established procedures. In the 7450-7550 and 8175-8215 MHz bands, it is agreed that although the military space radio communication systems which include earth stations near the proposed meteorological-satellite installations will take precedence over the meteorological-satellite installations, and engineering adjustments to either the military or the Meteorological-Satellite Systems or both will be made as mutually required to assure compatible operations of the systems concerned. In the 7250-7300 and 7975-8025 MHz bands, no 7975-8025 MHz assignments are to be made except those in accordance with the Government Table of Frequency Space Allocations and those for experimentation that is consistent with the use for which these bands are allocated. Existing assignments in the Fixed service supporting the air-traffic-control function, which may continue on a secondary basis in support of the Satellite service (fixed, transportable, or located on board a ship or aircraft) will be discontinued as soon as practicable, and not later than July 1, 1981.
7550-7750	Fixed Fixed-Satellite (space-to-earth) Mobile	
7750-7900	Fixed Mobile	
7900-7975	Fixed Fixed-Satellite (earth-to-space) Mobile	
7975-8025	Fixed-Satellite (earth-to-space)	
8025-8175	Earth Exploration-Satellite (space-to-earth) Fixed Fixed-Satellite (earth-to-space) Mobile	

Band (MHz)	Allocatio..	Recommendations and Remarks
8175-8215	Earth Exploration-Satellite (space-to-earth) Fixed Fixed-Satellite (earth-to-space) Mobile	
8215-8400	Earth Exploration-Satellite (space-to-earth) Fixed Fixed-Satellite (earth-to-space) Mobile	
8400-8500	Fixed Mobile Space Research (space-to earth)	

Band (GHz)	Allocation	Recommendations and Remarks
14.4-14.5	Fixed Mobile Space Research (space-to-earth on secondary basis)	The 14.4-14.5 GHz band is shared with non-Government users, and only non-Government users will be authorized in Fixed-Satellite service. Government and non-Government observations of the formal dehyde line frequencies within the 14.485-14.515 GHz frequency band may be made by certain observatories, and every practical effort should be made to avoid assignment of frequencies

Band (GHz)	Allocation	Recommendations and Remarks
14.5-15.35	Fixed Mobile Space Research (space-to-earth)	to stations in the Fixed and Mobile services in that band.
20.2-21.2	Fixed-Satellite (space-to-earth)	Military earth stations in this band may be fixed, transportable, or located on board a ship or aircraft.
21.2-22.0	Earth Exploration Satellite (space-to-earth) Fixed Mobile	These bands shared with non-Government allocations.
22.0-23.6	Fixed Mobile	
25.25-27.5	Fixed Mobile	Military earth stations in this band may be fixed, transportable, or located on board a ship or aircraft.
30.0-31.0	Fixed-Satellite (earth-to-space)	
36.0-38.6	Fixed Mobile	

Band (GHz)	Allocation	Recommendations and Remarks
40.0-41.0	Fixed Fixed-Satellites (space-to-earth) Mobile	Above 40 GHz all allocations for Government stations are shared with non-Government stations, although types of services are not necessarily the same for Government and non-Government usage.
41.0-43.0	Fixed Mobile	
50.0-51.0	Fixed Fixed-Satellite (earth-to-space) Mobile	
54.25-58.2	Fixed Inter-Satellite Mobile	
59.0-64.0	Fixed Inter-Satellite Mobile	
76.0-86.0	Fixed Mobile	
92.0-93.0	Fixed Fixed-Satellite (earth-to-space) Mobile	Military earth stations in this band may be fixed, transportable, or located on board a ship or aircraft

Band (GHz)	Allocation	Recommendations and Remarks
93.0-95.0	Fixed Fixed-Satellite (earth-to-space) Mobile	
102.0-103.0	Fixed Fixed-Satellite (earth-to-space) Mobile	Military earth stations in this band *may be fixed, transportable, or* located on board a ship or aircraft.
103.0-105.0	Fixed Fixed-Satellite (space-to-earth) Mobile	
105.0-110.0	Fixed Inter-Satellite Mobile	
110.0-110.0	Fixed Inter-Satellite Mobile	
110.0-117.5	Fixed Inter-Satellite Mobile	
117.5-122.5	Fixed Inter-Satellite Mobile	

Band (GHz)	Allocation	Recommendations and Remarks
122.5-130.0	Fixed Inter-Satellite Mobile	
140.0-141.0	Fixed Fixed-Satellite (earth-to-space) Mobile	Military earth stations in this band may be fixed, transportable, or located on board a ship or aircraft.
141.0-142.0	Fixed Fixed-Satellite (earth-to-space) Mobile	
150.0-151.0	Fixed Fixed-Satellite (space-to-earth) Mobile	Military earth stations in this band may be fixed, transportable, or located on guard a ship or aircraft.
151.0-152.0	Fixed Fixed-Satellite (space-to-earth) Mobile	
152.0-165.0	Fixed Mobile	
170.0-175.0	Fixed Inter-Satellite Mobile	

Band (GHz)	Allocation	Recommendations and Remarks
175.0-182.0	Fixed Inter-Satellite Mobile	
185.0-189.0	Fixed Inter-Satellite Mobile	
189.0-190.0	Fixed Inter-Satellite Mobile	
200.0-220.0	Fixed Mobile	
220.0-230.0	Fixed Fixed- Satellite Mobile	Applicants for space stations assignments are urged to take all steps to protect observations in adjacent exclusive radio astronomy channels.
265.0-275.0	Fixed Fixed- Satellite Mobile	
275.0-300.0	Fixed Mobile	
Above 300.0	(Not Allocated)	

SUPPLEMENT II

MILITARY STANDARDS, MIL-STD-188 SERIES

MIL-STD-188C	Military Communication System Technical Standards, 24 November 1969 (to be replaced by MIL-STD-188-200 series)
MIL-STD-188-300	Standards for Long Haul Communications System Design Standards Applicable to the Defense Communications System, 15 July 1971
MIL-STD-188-310	Subsystem Design and Engineering Standards for Technical Control Facilities, 2 August 1971
MIL-STD-188-311	Equipment Technical Design Standards for Multiplexers, 10 December 1971
MIL-STD-188-313	Subsystem Design and Engineering Standards and Equipment Technical Design Standards for Long-Haul Communications TransversiTransversing Microwave LOS Radio and Tropospheric Scatter Radio
MIL-STD-188-315	Subsystem Design/Engineering Standards for Wire Systems, 30 July 1971
MIL-STD-188-317	Subsystem Design/Engineering Standards for High Frequency Radio, 30 March 1972
MIL-STD-188-322	Subsystem Design/Engineering and Equipment Technical Design Standards for Long Haul Line-of-Sight (LOS) Digital Microwave Radio Transmission
MIL-STD-188-340	Equipment Technical Design Standards for Voice Orderwire Multiplex, 21 May 1971
MIL-STD-188-341	Modem Non-Diversity Digital Data 2400 Bits Per Second
MIL-STD-188-342	Equipment Technical Design Standards for Voice Frequency Telegraph (FSK), 29 February 1972
MIL-STD-188-344	Modem, Non-Diversity Digital Data, 1200 Bits Per Second, 1 June 1972
MIL-STD-188-346	Equipment Technical Design Standards for Analog End Instruments and Central Office Ancillary Devices
MIL-STD-188-347	Equipment Technical Design Standards for Digital End Instruments and Ancillary Devices

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Reference

B-1 Final Acts of the World Administrative Radio Conference, Geneva, 1979 (Draft document supplied by State Dept.)

B-2 CCIR XII th Plenary Assembly, Kyoto, 1978

B-3 CCITT Sixth Plenary Assembly, Orange Book, Geneva, 1976

B-4 EURCOM D/1, September 1977

B-5 US NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management, January 1980

B-6 ARFA (Allied Radio Frequency Agency) Policy Handbook